

# POISONS

# POISONS

PROPERTIES, CHEMICAL IDENTIFICATION, SYMPTOMS  
AND EMERGENCY TREATMENT

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by

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To  
*Gail and Michael*

## FOREWORD TO THE SECOND EDITION

Publication of this book is made by the authors as a public service.

As a sergeant of the New Jersey State Police, and later Lieutenant and Medical Administration Officer before his retirement to become Chief of Plant Protection at Spaulding Works of Crucible Steel Company of America, Lieutenant Brookes had recognized the necessity for a text book on the subject of poisons that would assist police officers, hospital personnel, and industry, as well as the layman, in recognizing immediate symptoms of poisoning. With this purpose in mind, and with the thought that in emergency cases action should be based on an intelligent knowledge of the proper treatment, Lieutenant Brookes and Dr. Jacobs have prepared the revision of the first edition of this book.

It gives me great pleasure to recommend this book as a textbook for study, and a book worthy of careful reading.

PAUL A. KARNS

*Manager, Spaulding Works*

*Crucible Steel Company of America*

## PREFACE TO THE SECOND EDITION

The objective of this edition is the same as that of the first edition, namely, a handbook in simple language, ready for rapid reference, with a minimum of technical details, on the effects and emergency treatment of poisoning.

There has been an expansion of the use of chemicals in the home and in industry since the first edition, in particular, there is a growing use of insecticides, fungicides, rodenticides, agricultural chemicals, cleaners, polishes, and the like, containing poisonous substances. Descriptions of these and the emergency treatment for poisoning from them have been added to the book. A new chapter on radiation hazards and on chemical warfare agents has also been added.

In order to make the chapter "Emergency Information for Immediate Reference" more useful, an entirely new section of ingredients of common household products has been added. When a poisoning occurs, often only the class of product—for instance, antifreeze, cleaner, polish, rat killer—is known. The ingredient listing will be helpful in limiting the items that need to be considered in emergency treatment. The table of maximum allowable concentrations of substances used industrially has been brought up to date. The section on food poisoning has been expanded, since this is a most common cause of poisoning.

This book is designed to be of help to police, peace officers, and investigators. The material it contains should be particularly useful to people such as high school chemistry and science teachers who are asked to assist in investigations of poisoning in areas where they are the principal scientific personnel. We believe the book will be of value to physicians, nurses, toxicologists, chemists, pharmacists, safety engi-

neers, industrial hygienists, and poisoning control and civil defense workers. It would be of great help in the home.

The authors of the second edition wish to express their thanks to those who wrote to us about the first edition, and in particular to Mr. Kurt M. Dubowski, whose painstaking review of the first edition was so helpful to us in the preparation of the second.

It must be stressed that in every case of poisoning a physician should be called immediately and if there is a poisoning control center in the community, that should be consulted.

VINCENT J. BROOKES  
MORRIS B. JACOBS

*Trenton, New Jersey*  
*Bayside, New York*  
*September, 1958*

## PREFACE TO THE FIRST EDITION

Here in simple language, ready for rapid reference, with a minimum of technical details, is a handbook on the effects and emergency treatments of poisons. Since the majority of books on this subject are entirely too technical for the layman to gain a clear knowledge of what *occurs in the human body when poisons are taken*, we feel that this manual satisfies a real need.

Originally written for police, investigators, and peace officers, this material will, we believe, be of value also to physicians, nurses, chemists and pharmacists. It would even be valuable in the home.

The police officer, because he is very often at the scene within a few minutes after an occurrence, should be familiar with emergency treatments. At such a time he obviously cannot be expected to recall the mass of technical material found in most treatises on poisons. With this in mind, we have summarized in this handbook the important facts on the subject of poisons that he should remember in order to investigate intelligently and give help immediately. This book has developed out of the experience of one police organization, and it is our hope that, as a reference work, it will assist others in their development of an effective investigation procedure.

An introductory chapter deals with the factors that should be noted during a poison investigation. The next three chapters treat some one hundred and fifty common poisons, arranged alphabetically, describing their preparation and uses, chemical identification, the symptoms they produce, and the emergency treatments recommended for them.

There is a chapter on industrial poisons and one on special topics: food, plant, snake, and spider poisons. Certain special techniques are described: artificial respiration, use of the gas mask and the inhalator,



and treatment for shock. A glossary of medical terms, a list of analytical reagents, and tables of weights and measures conclude the book.

The authors have striven wherever possible to designate trade names by capitalizing the first letter of the name. This is at best a difficult task and there may be instances where the convention has not been observed.

*It is to be remembered that this is a book on the effects of poisons; in no sense should the stated normal doses be employed as a basis for prescriptions. Furthermore, fatal doses may vary considerably with the idiosyncrasy of the individual, and must be so judged.*

Acknowledgment and thanks are due to the many persons who assisted us in formulating the original manuscript: to Dr. Robert P. Fischelis, Secretary and General Manager, American Pharmaceutical Association, Washington, D. C.; to John E. Hatrak, PhG. and Nelson J. Miles, PhG. for their valuable additions and suggestions; to Dr. Albert E. Edel, noted toxicologist, who has given us the benefit of his years of experience; and to Margery Lumsden and Jean Winkler for their clerical assistance.

We wish to thank Merck and Co., Inc. for allowing us to quote doses of drugs from the *Merck Index*, fifth edition. We are indebted also to Interscience Publishers, Inc., for permission to quote dangerous concentrations of industrial chemicals from M. B. Jacobs, *Analytical Chemistry of Industrial Poisons, Hazards and Solvents*.

Above all, this book was made possible by Colonel Charles H. Schoeffel, Superintendent of the New Jersey State Police, who allotted the time for the extensive work involved.

V.J.B.  
H.N.A.

Trenton, N. J.  
Princeton, N. J.  
July, 1945

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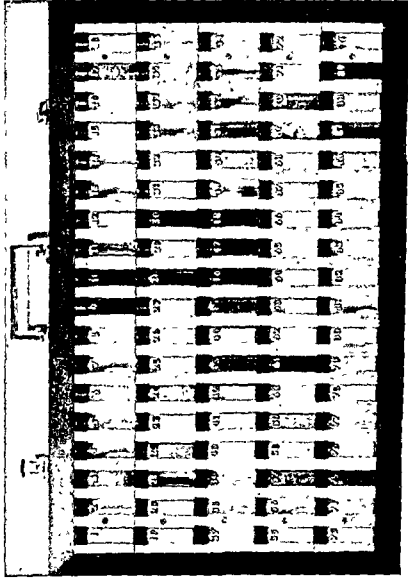
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- |                                 |                           |
|---------------------------------|---------------------------|
| 1. Acetanilid                   | 28. Barium sulfide        |
| 2. Acetic acid                  | 29. Barium sulfite        |
| 3. Carbolic acid                | 30. Belladonna, tincture  |
| 4. Hydrochloric acid            | 31. Bismuth subgallate    |
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| 19. Antipyrine                  | 46. Creolin               |
| 20. Apomorphine                 | 47. Creosote              |
| 21. Arnica                      | 48. Cresol                |
| 22. Arsenic                     | 49. Croton oil            |
| 23. Atropine                    | 50. Digitalis             |
| 24. Phenobarbital               | 51. Ergot                 |
| 25. Barium acetate              | 52. Ether                 |
| 26. Barium carbonate            | 53. Formaldehyde solution |
| 27. Barium chloride             | 54. Gasoline              |

- |                            |                            |
|----------------------------|----------------------------|
| 55. Hydroquinone           | 73. Potassium carbonate    |
| 56. Hydrogen peroxide      | 74. Potassium hydroxide    |
| 57. Iodine                 | 75. Potassium permanganate |
| 58. Iodoform               | 76. Silver nitrate         |
| 59. Lead                   | 77. Snake venom            |
| 60. Lye                    | 78. Sodium fluoride        |
| 61. Lysol                  | 79. Sodium hydroxide       |
| 62. Mercury bichloride     | 80. Strychnine             |
| 63. Mercuric oxide, red    | 81. Turpentine             |
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| 65. Mercurous chloride     | 83. Zinc chloride          |
| 66. Morphine               | 84. Zinc sulfate           |
| 67. Opium                  | 85. Zinc acetate           |
| 68. Phenacetin             | 86. Ant buttons            |
| 69. Phosphorus, white      | 87. Ant X                  |
| 70. Phosphorus, red        | 88. Black flag             |
| 71. Picric acid            | 89. Black leaf             |
| 72. Potassium chlorate     | 90. Drano                  |

## POISON INVESTIGATION

**Definition of a Poison.** A poison is a substance which, when introduced into a living organism in sufficient amounts, may have an injurious or deadly effect, chemically producing a morbid or noxious condition.

Poison usually gets into the system through the mouth by swallowing (orally) or breathing, into the bloodstream (intravenously), under the skin (subcutaneously), or by absorption through the skin.

**Kinds of Poisons.** Poisons may be described in many ways: according to their chemical compositions, their action on the body, their physical characteristics, etc. The following is a simple and convenient classification:

*Corrosive Poisons*—which by their direct action destroy the tissues with which they come in contact.

*Irritant Poisons*—which inflame the mucous membranes by direct action.

*Systemic Poisons*—which act on the nervous system or other important organs of the body without having any special corrosive or irritant effects.

*Poisonous Gases*—including carbon monoxide, chlorine, etc.

*Foods Which May Be Poisonous*—which may contain (1) poisonous bacilli; (2) chemicals accidentally mixed in the foods (e.g., sodium fluoride, an ingredient in many roach and insecticide powders). (3) Also, poisonous fungi are sometimes mistaken for edible mushrooms.

**Poisoning May Be Accidental, Suicidal, or Homicidal.** Cases of accidental poisoning are far more numerous than those with suicidal or homicidal intent, as is indicated in Table I.

TABLE 1. DEATHS RESULTING FROM POISONING\*

HOMICIDES	
Phosphorus .....	3
Cyanide .....	2
Illuminating gas .....	2
	<hr/> 7
SUICIDES	
Barbiturates .....	103
Illuminating gas .....	75
Motor exhaust .....	13
Cyanide .....	8
Phosphorus .....	8
Arsenic .....	3
Sodium hydroxide (lye) .....	3
Illuminating gas and strangulation .....	2
Ammonia .....	2
Barbiturate and morphine .....	2
Carbon tetrachloride .....	2
Fluorides .....	2
Illuminating gas and barbiturate; illuminating gas and hanging; cyanide, isopropyl alcohol, and cutting; muriatic acid and cutting; phenol and cutting; phenobarbital and drowning in bathtub; barbiturate and drowning in bathtub; ammonia and iodine; barbiturate and chloral; chloral hydrate; cresol (Lysol) and salicylate; digitoxin; Dormin; heroin and morphine; methyl salicylate (oil of wintergreen); mercury; morphine; morphine and salicylate; Pantopon; potassium hydroxide; salicylate (salicylic acid); sodium hydroxide (Drano); 1 each .....	23
	<hr/> 246
ACCIDENTAL AND UNDETERMINED	
Ethyl alcohol .....	541
Drug addiction (principally heroin, morphine, or heroin and morphine, with isolated instances of a narcotic and some other toxic material) .....	100
Barbiturates .....	70
Lead .....	17
Methyl alcohol (wood alcohol) .....	8
Carbon tetrachloride .....	4
Paraldehyde .....	3
Sodium hydroxide (lye) .....	3

\* Compiled from the Report of the Chief Medical Examiner of the City of New York for the year 1953, the latest available.



## ACCIDENTAL AND UNDETERMINED—CONTINUED

Ammonium hydroxide .....	2
Chloral hydrate .....	2
Acetic acid, arsenic, camphor, boric acid, formaldehyde, isopropyl alcohol, methyl salicylate (oil of winter- green), nitrobenzene, phenol, phosphorus, potassium dichromate, thallium: 1 each ..	12
	<hr/> 762
Grand total .....	1015

**Action of Poisons.** The action of poisons may be local; or there may be a general systemic reaction after the poison is absorbed into the circulatory system, or the poisons may act in both ways.

**Local Action.** Corrosive poisons destroy or cause serious injury to the mucous membranes or tissues with which they come in contact. Other poisons set up a local inflammatory reaction in the mucous membrane of the alimentary tract; still others act on the nervous system or other important organs of the body, such as the heart, lungs, kidneys, liver, without having any special irritant or corrosive effects.

**Systemic Reaction.** Following the local action, the poison is usually absorbed into the bloodstream and produces harmful effects on the vital organs of the body. In fact, a poison attacks almost all the organs of the body to some degree, therefore, it is hardly possible to regard any particular poison as being merely selective in its action, even when it appears to direct the brunt of its force on some particular system.

**General Conditions that Control the Action of Poisons.** The investigator at the scene of a poisoning should carefully consider certain conditions in relation to his diagnosis of the injured person. These conditions include:

**Administration.** Poison dissolved to form a solution and taken by mouth (orally) will act more rapidly than if taken in solid form. Poisons administered intravenously or subcutaneously produce a more powerful response than if taken by the mouth. When poisonous gases, vapors, or sprays are inhaled, their absorption is rapid, and the effects great. It is also possible for poisons to be absorbed with fatal results through the skin or mucous membranes of the rectum or vagina.

**Age.** As a general rule infants and children are more susceptible to the effects of a poison than are adults. There are certain exceptions

to this rule; for example, children are less susceptible to the action of belladonna, calomel, and strychnine.

*Food.* Food in the stomach has a marked influence on the effect of a poison: when the stomach is empty the effects will be rapid, but when the stomach is full there may be considerable delay in the action of a poison.

*Habit.* Certain poisons repeatedly taken in small doses cause the build-up of a tolerance, so that if the dose is gradually increased, relatively large doses may in time be taken without toxic symptoms. With some poisons, their repeated use often leads to the development of the "drug habit." The tolerance for a poison, through habit, is not absolute; toxic effects and death may result if the limit of the dose that is being taken habitually is slightly exceeded. This fact explains, for example, the deaths of morphine addicts from morphine poisoning.

A tolerance cannot be acquired for the majority of poisons: mercury or antimony, for example, cannot be taken even in small amounts for any length of time without ill effects.

*Health.* Persons who are ill are found to be more susceptible to drugs than persons enjoying good health.

*Idiosyncrasy.* When an individual exhibits unusual reactions to a certain poison, he is said to have an idiosyncrasy. Some poisons will induce effects exactly opposite to those ordinarily produced; for example, the use of morphine in certain individuals may cause wakefulness rather than sleep.

*Quantity.* The quantity of a poison taken often bears a close relation to the effects produced. There is also an exception to this rule, because some substances when taken in excess cause vomiting, which results in much of the poison being expelled. The term "fatal dose," when applied to a poison, means the smallest amount known to have caused the death of an adult.

*Hints for the Investigator.* It is not necessary that the investigator become an expert on poisons, since he will have the knowledge and assistance of the medical examiner, coroner, toxicologist, or other specialist; but it will be of great help to him to know the symptoms of various kinds of poisoning, the amounts of specific poisons that will cause death, and the length of time that may elapse, after the poison has been taken, before death occurs. Very often additional knowledge relative to a poison is helpful, for example, where the poison is ob-

tained, its chemical formula, other names it is known by, in which industries it is used, and what the antidote is.

A murderer does not use poisons having extreme odors, colors, or tastes, as they may tend to raise suspicion in the intended victim. A suicide, on the other hand, may take any poisonous substance regardless of its odor, color, or taste.

When deaths where poisoning is suspected are being investigated, sight and smell are of utmost importance. A thorough search and check should be made of the surroundings; the position and appearance of the body; the skin in and about the mouth, lips, rectum, vagina, and the genitals, the pupils of the eyes—whether contracted or dilated, odors present, possible marks on the skin as a result of hypodermic needle injections; and the hands, for the presence of objects. The investigator should try to determine whether an object found in the hand was grasped before death, or placed in the hand after death occurred: if the fingers do not grasp the object tightly, the body was in death when the object was placed

If it is learned that symptoms appeared soon after a drink or meal was taken, the investigator should be extremely thorough in seeing that all liquids, foods, and medicines on the premises are preserved. A search should be made of the medicine cabinet, pantry, refrigerator, and even the refuse container. If many hours have elapsed after the meal was ingested, the possibility of food as the agent conveying the poison may be eliminated. Where symptoms of poisoning have been observed, the investigator can reasonably assume that the victim had taken the poison from one half to one hour before the first symptoms appeared, although in strong acids and alkalies symptoms are present immediately.

The presence of poison must be proved. Probably one of the best methods is by chemical analysis. This can be made on the foods or liquids suspected, or on the contents of the stomach following the post-mortem examination. A specimen of the vomitus should be taken for analysis.

A careful questioning of persons should be made, especially of those who saw the victim shortly before his death. Check those who might have had a motive to do away with the deceased, particularly those benefiting from the death. A thorough search should be made for notes or letters of departure to friends and relatives. Many times these letters are hidden away with bits of other evidence to avoid unpleasant

publicity. Check the history of the victim to learn whether there was any reason, fancied or real, for him to destroy himself.

Many times persons attempting to commit suicide try more than one method before finally succeeding. For example, a person may try one method, then jump out a window; or after taking a poison, he may hang or shoot himself. When preparations have been made to make death certain, such as attaching a tube to a gas jet and inserting the opposite end in the nose or mouth and sealing cracks and openings around the doors and windows to prevent the escape of gas, suicide can be suspected, but not absolutely proved; for cases are sometimes made to look suicidal by the person committing the crime. If the victim, after taking the above precautions locks himself in a room in such a manner that there could be no possibility of a homicide, then and then only is suicide to be accepted as a fact.

**First Aid.** The investigator should familiarize himself with the general symptoms of various kinds of poisoning and emergency treatments, so that he can speedily render first aid, if it is not too late for such treatment. The necessary information is supplied in Chapters 3, 4, and 5.

**Rigor Mortis.** After death the body develops a stiffness known as rigor mortis. This is the result of chemical changes in the muscle protoplasm. After death the reaction is slightly alkaline for a short period, and as long as this persists the muscles are flexible. Two to six hours after death the reaction changes from alkaline to acid, at which time rigor begins to develop in the face, jaw, upper extremities, trunk, and the lower extremities, occurring in about the sequence named. The process completes itself in approximately two hours. The muscles not only become rigid but shortened as well. It is not easy to change the position of the body after rigor has developed, because of the stiffness. This stiffness lasts from twelve to forty-eight hours, until the muscles again become alkaline from further chemical change, after which the rigor slowly passes off. The body loses its rigidity in about the same sequence it appeared.

Conditions alter the onset, persistence, and disappearance of rigor mortis. Where the individual died in convulsions or in strong muscular activity, the rigidity may appear within an hour. There are cases recorded where the entire body became rigid almost immediately following death. Individuals with developed muscles take on

post-mortem rigor more slowly than others and retain it for a longer time. Those with poorly developed muscles, and thin people and infants, become stiff more rapidly and lose the rigidity faster. Heat speeds the onset of rigidity and hastens its ending. Cold hastens the onset but retards its dissolution, so that stiffness is retained for many days. In some cases it may be necessary to tell true rigor mortis from the stiffness resulting from cold or electric shock.

The eyeball glistens immediately following death, and within a few hours is covered with a thin transparent film of dried secretion.

Publicity. Something should be said regarding the publicity given in the investigation of poisoning cases. Many druggists, for instance, have received public blame erroneously, and as a result have lost their business because the facts of a case were not given to the newspaper in proper detail. There is a case on record of a man who received from a druggist strychnine on a doctor's prescription, with instructions for safe dosages. The victim, getting good results with the drug properly administered, figured he would have quicker results by taking larger doses; in doing so he gave himself an accumulated overdose, which proved fatal. The state held the druggist; but upon investigation found that the prescription was compounded perfectly. However, the unpleasant notoriety forced the druggist out of business. If the facts had been explained in the first news release, a false impression, supplemented by false fears that they might be future "victims," would not have seized the public, and they would not have lost faith in the druggist's reliability.

# 2

## BASIC INFORMATION FOR THE INVESTIGATOR

### CHEMICAL INFORMATION

**Chemical Elements.** A brief description of chemical formulas is in order at this point. All matter is built up of tiny particles called atoms of elements. There are atoms of copper, atoms of sulfur, atoms of iron, and so forth. The chemist represents each of these elements by a kind of chemical shorthand, called chemical symbols. The symbols encountered in this book are:

Ag	silver	Ca	calcium	K	potassium	Pb	lead
As	arsenic	Cl	chlorine	Mn	manganese	S	sulfur
B	boron	F	fluorine	N	nitrogen	Sb	antimony
Ba	barium	H	hydrogen	Na	sodium	Zn	zinc
Bi	bismuth	Hg	mercury	O	oxygen		
C	carbon	I	iodine	P	phosphorus		

Although there are about ninety-two naturally occurring different elements (the total including those prepared artificially was 101 in 1958 and more may be prepared as artificial products of nuclear reactions) in the world, with corresponding symbols, only a few are really common. Thus one-half of all the earth's crust is oxygen; one-quarter is silicon. The human body is chiefly oxygen (64%), carbon (20%), and hydrogen (10%); the rest is calcium (2%), nitrogen (2%), phosphorus (1%); all other elements add up to only 1%.

**Atoms Combine to Form Compounds.** Elements may combine chemically. For example, the smallest part of carbon monoxide, the deadly gas present in automobile exhaust gas, contains one atom of carbon and one atom of oxygen. Carbon monoxide is written CO; this is called a molecule of carbon monoxide. A molecule is the

smallest amount of matter still retaining the characteristics of any particular substance. A molecule of water contains two atoms of hydrogen and one atom of oxygen, written  $H_2O$ .

Some molecules contain more than two elements. For instance, sodium carbonate or washing soda,  $Na_2CO_3$ , contains sodium, carbon, and oxygen; and sodium bicarbonate or baking soda,  $NaHCO_3$ , contains sodium, hydrogen, carbon, and oxygen; thus a molecule of each of these compounds contains at least six atoms.

Sometimes the different ratio of atoms in the molecule forms different compounds. As examples, there are sodium nitrite,  $NaNO_2$ , with two atoms of oxygen and sodium nitrate,  $NaNO_3$ , with three. Organic materials, such as the alkaloids, may have a great number of different atoms. Morphine, for instance is  $C_{17}H_{19}O_3N \cdot H_2O$ , which means that it contains water ( $H_2O$ ) in the compound itself, together with 40 other atoms. Salts of alkaloids containing acid groups, such as morphine sulfate, are prepared in such a way as to make them water-soluble. Also the way atoms are joined together in space often changes their properties. There are, for instance, 32 different kinds of sugar, like glucose or grape sugar, with the formula  $C_6H_{12}O_6$ .

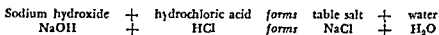
**Acids and Alkalies.** Some compounds are closely related. This causes them to react chemically alike, and makes the symptoms and treatment of poisoning by these substances similar.

*Acids* all contain hydrogen, turn litmus pink, and are sour to the taste, for example,  $HCl$ , hydrochloric acid,  $H_2SO_4$ , sulfuric acid;  $HNO_3$ , nitric acid. These are very powerful acids, and seriously corrode and damage human tissue, often causing death. Other acids are relatively harmless in dilute solution. Carbonic acid ( $H_2CO_3$ ), for instance, forms the fizz in soda water and soft drinks; and vinegar contains about 5% acetic acid, ( $HC_2H_3O_2$ ).

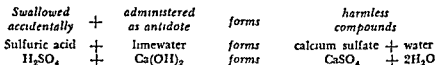
*Alkalies*, also called bases or hydroxides, all contain the hydroxyl group ( $OH$ ), turn litmus blue, and feel soapy: for example, sodium hydroxide,  $NaOH$ ; potassium hydroxide,  $KOH$ . These two are powerful, corrosive alkalies called caustic alkalies. Caustic alkalies burn and destroy human tissue. (The word caustic is derived from the Greek *kaustikos*, "burning.") Other alkalies are relatively weak, for example, calcium hydroxide or limewater,  $Ca(OH)_2$ ; dilute ammonium hydroxide,  $NH_4OH$ .

**Neutralization to Form Salts.** Salts are compounds formed when

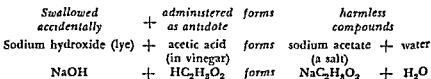
acids react with alkalis; this process is called neutralization. The chemist represents this by means of a chemical equation. For instance, when sodium hydroxide (lye) reacts with hydrochloric acid, common table salt is formed. The chemical shorthand for this reaction is:



This process of neutralization is utilized in treating for poisoning from acids, or from bases. If a strong, powerful acid such as sulfuric acid has been swallowed, a weak alkali such as limewater is administered, and chemically neutralizes the acid:



If on the other hand a powerful caustic alkali such as sodium hydroxide has been swallowed, the patient is given a weak acid such as citric acid in fruit juices, or acetic acid in vinegar; this nullifies the damaging effect of the caustic by neutralizing it:



Notice that only weak acids or weak alkalis are administered. *Never give the patient a strong acid or a strong alkali: it will do as much harm as the original poison. Never give washing soda; it acts like a strong alkali.*

If only a very dilute solution of an acid has been swallowed, certain carbonates may be used to nullify the effect of the acid. While chemically speaking this is not strictly neutralization as defined in a preceding paragraph, its effect of destroying the acid is the same. This is best effected by the administration of weak alkalis, as the carbonates, or calcined magnesia. The carbonates use up the acid and form carbon dioxide. In an emergency, soap suds or whiting may be used. It must be remembered that all antidotes given should be dissolved in large amounts of liquids (water or milk).



Swallowed accidentally	+	administered forms as antidote		harmless compounds				
Very dilute (5%) hydrochloric acid	+	calcium carbonate	forms	calcium chloride	+	water	+	carbon dioxide
Dilute HCl	+	CaCO <sub>3</sub>	forms	CaCl <sub>2</sub>	+	H <sub>2</sub> O	+	CO <sub>2</sub>

**Carbonates and Acids.** *A carbonate should never be administered if the acid poison is concentrated, because the carbon dioxide gas may be evolved so vigorously that it damages the already injured tissue of the stomach.*

**Sources of Drugs.** Mineral, vegetable, or animal substances that may irritate, soothe, or otherwise affect human tissue are used as drugs. (1) Minerals treated chemically produce acids, alkalies, and salts. (2) Vegetables yield drugs from various sections of the plant—flowers, fruit, sap, roots, bark, and in many instances the entire plant. The crude drug obtained from the plant is not often used; usually it is treated by physical or chemical methods. The crude drug from which the alkaloids are prepared is treated with various solvents which extract or dissolve out the active ingredients (for example, morphine from crude opium); and these active ingredients may themselves later be treated chemically to produce other drugs (for example, apomorphine from morphine). (3) Animal organs from which drugs are prepared include the pancreas, the thyroid, and other glands.

**Important General Drugs.** *Alkaloids* are found in plants or are made chemically from plant extracts. They consist largely of carbon, hydrogen, and nitrogen. Alkaloids do not dissolve readily in water, but their salts do (for example, morphine sulfate, cocaine hydrochloride); and these salts are the preparations generally used in medicine.

*Allergy agents* are drugs used to allay allergic manifestations. Many of these are antihistamine or histamine-antagonizing agents like Pyribenzamine, Benadryl, Chlortrimeton.

*Analgesics* are drugs that relieve pain without causing loss of consciousness. Some of such drugs are alkaloids like morphine. There are a number of synthetic chemicals that are used for this purpose. Meperidine hydrochloride (Demerol hydrochloride) is an example of a nonopiate, addicting analgesic.

*Anesthetics* may be general, like ether, chloroform, or cyclopropane, which cause loss of consciousness; or local, causing loss of sensitivity

*Paint Removers.* Methyl alcohol, ethyl alcohol, benzene, acetone, methylene chloride, ethyl acetate, ethyl methyl ketone.

*Antifreezes.* Ethylene glycol, methyl alcohol.

**Doses.** Poisons do not always injure or kill; in fact for any given poison there may be some small concentration that is beneficial to the body. Accordingly poisons are often found in medical preparations, and are thereby the source of accidental poisoning. The quantity of these substances to be safely administered as medicines of course varies greatly with the disease, the weight, sex, age of the individual, and so on. The average adult doses given in this book have been taken from the Merck Index (Sixth Edition, 1952). For a child, apply Cowling's rule:

$$\text{Child's dose} = \frac{\text{age on next birthday}}{24} \text{ times adult's dose.}$$

Thus a child who will be six on the next birthday should take  $\frac{6}{24}$  or  $\frac{1}{4}$  of the prescribed adult dose. Fatal overdoses would vary greatly in different cases, and are stated here only as an approximate guide for the investigator.

In cases where several concentrations of the same medicine are on the market, the investigator should be careful to determine which one has been taken. As an example, tincture of iodine used to contain anywhere from 2% to 16% iodine; 2% is the most common. Creosote from wood tar is occasionally prescribed, but creosote from coal tar cannot be taken without harmful results. Concentrated acids are violently corrosive, but the same acid in diluted form may not be very dangerous.

## IDENTIFICATION BY CHEMICAL MEANS

The accurate identification of a poison should be done only by a toxicologist trained and skilled in chemical analysis. He will examine the organs, excretions, and tissues of the body for poisons. Set all excretions and vomitus aside for him in scrupulously clean airtight glass jars with glass or resistant plastic (not metal) closures; never add preservatives, for this will ruin the chemical tests he is to make.

It often happens, however, that the substance swallowed must be quickly identified, before a toxicologist arrives. *Here is the patient. Here is the vial of white powder he has swallowed. We think it is white arsenic. Is it?* To answer just such questions, this chapter gives

simple, rapid chemical tests. Their very simplicity means that they are not so conclusive as the painstaking analysis that the toxicologist will later carry out.

The appendix has a complete list of chemicals required to carry out all tests in this book. The investigator should prepare a kit of these chemicals; and especially practice the tests on known samples, so that he is familiar with them if ever called to put them to actual use.

*If the police officer intends to carry out the chemical tests described in this section it will be advisable for him to receive expert instruction for several weeks by a trained toxicologist or chemist in these special techniques.*

**Preliminary Examination of Poison.** (1) First examine the label on the bottle or container that held the poison. Consider the source of the poison: that is, if it is rat poison, suspect arsenic; if paint, suspect lead, and so on. (2) Next try to estimate whether the poison is still in the stomach, or has passed into the intestines or bloodstream: consider, for instance, how much time has elapsed since the poison was taken, whether it was taken as granules (slowly absorbed) or as a water solution or alcoholic solution (quickly absorbed). This will tell you how quickly you must act; for example, if cyanides have undoubtedly been taken, act without a moment's delay; for with that poison death follows swiftly. (3) Then examine the poison itself, noting whether it is liquid or solid; whether it is an amorphous powder or crystalline needles, flakes or scales; whether it is moist (deliquesces). (4) Notice its color, remembering that white substances are easily discolored by aging or by impurities. (5) Sniff, but do not inhale it, remembering that characteristic odors may be hidden by other smells, or that the poison may have evaporated. (6) Test it with moistened litmus paper: paper turning pink indicates an acid; paper turning blue indicates an alkali.

**General Technique.** There are several precautions that any investigator must observe in carrying out the tests: (1) Most important is extreme cleanliness; the slightest trace of foreign matter will ruin a chemical test. (2) Never taste anything, assume that all chemicals are poisonous; wash hands thoroughly before turning to the patient after carrying out these chemical tests. (3) When using the alcohol burner, heat gently; keep the mouth of the tube pointed away from your own face or other persons; keep your hand away from the base of the lamp,

where concentrated acid might spill if the tube breaks. (4) Use small quantities of reagent: a few drops often give better color reactions than a tubeful.

**Preparing the Unknown for Analysis.** Following the preliminary examination, prepare the unknown sample and turn to the individual tests given under each poison. *Important: Use only a small bit of your unknown sample; save the rest for later tests; and above all, leave most of the sample for the toxicologist to test.* The unknown is either the original poison, the vomitus, or the breath. Examination and testing of tissues of the body should be left to the toxicologist. The sample must be properly prepared before the tests can be carried out.

**A Gas:** If the unknown is a gas, its identity can often be determined by its odor, as most gases have characteristic odors. However, test papers may be used and are very convenient. The gas may be tested directly, or dissolved in water and the solution tested.

**A Liquid.** Test directly.

**An Inorganic Solid.** Dissolve a pinch in 10 cc. water, heated if necessary to boiling; usually enough of the solid will pass into solution to test directly.

**An Alkaloid.** Test a pinch of the unknown for solubility in water (for example, alkaloid salts). If it appreciably dissolves, test directly. If it does not dissolve, shake up a small portion with ethyl alcohol (95%) and test the clear liquid that remains after any undissolved solid has settled. A third procedure for putting sufficient alkaloid into solution is to add dilute hydrochloric acid drop by drop to a pinch of the powder, until the powder goes noticeably into solution (it may completely dissolve); then use the clear liquid for the color tests.

The above procedures are much more simplified than the elaborate techniques that the toxicologist must use to put the alkaloids into solution, but will serve the purpose for color tests.

**Other Organic Solids.** Dissolve a pinch in 10 cc. water heated to boiling; or 10 cc. alcohol heated to boiling. If neither solvent dissolves the solid, shake with ether.

**Spot Tests for Metals.** On a porcelain plate place 3 separate drops of the aqueous solution of unknown, or 3 pinches of solid unknown. Add 1 drop of aq. ammonium carbonate to sample 1; 1 drop of aq. ammonium sulfide (white, not yellow) to sample 2; and 1 drop of aq.

potassium iodide to sample 3. Colors obtained with inorganic salts of various metals are found in Table 2. Sometimes no results are obtained if the metals are in organic compounds.

TABLE 2. SPOT TEST FOR METALS

SALTS OF—	AMMONIUM CARBONATE	AMMONIUM SULFIDE	POTASSIUM IODIDE
Antimony	White	Orange	...
Arsenic	...	Yellow, forms slowly; sol. in excess	...
Barium	White	...	...
Bismuth	White	Brownish black	Dark brown; sol. in excess
Cadmium	White	Yellow	...
Copper	Light blue	Black	Brown
Lead	White	Black	Bright yellow
Mercuric salts	White	Black	Green, turning red
Mercurous salts	White	Black; brown to black	Green; yellow-red mixture "parrot color"
Silver	White	Black	White turning purplish in light
Zinc	White	White; sol. in excess	...

**Flame Tests.** Some metals in salts can be easily identified by the color they impart to flames; the test follows. Melt the tip of a 6-inch glass rod, and while the rod is soft, push in about  $\frac{1}{8}$  inch of a 3-inch platinum wire. Use this for flame tests. Dip the wire into dilute hydrochloric acid and hold it in the flame. Repeat until the yellow color of the sodium flame no longer persists. Hydrochloric acid is used since it forms chlorides which volatilize easily. Now dip the wire into a solution of the unknown, and hold it in the flame. The various metals are indicated by characteristic colors as follows:

Red: strontium, lithium  
Orange red: calcium  
Yellow: sodium

Green: barium  
Greenish-blue: copper  
Violet: potassium

Spot Tests for Alkaloids and Narcotics. Pure samples, water solutions of alkaloid salts, or the solutions prepared as described on page 16, will yield the tests as shown in Tables 3A and 3B. A small portion

TABLE 3A. SPOT TESTS FOR ALKALOIDS

COLOR	DILUTE $H_2SO_4$	CONCEN- TRATED $HNO_3$	FROHDE'S REAGENT *	MANDELIN'S REAGENT †	POTASSIUM FERRO- CYANIDE
Red	Morphine (turns violet)	Brucine (red changing to yellow)	Brucine	Morphine	...
Orange	...	Morphine	...	...	Caffeine
Yellow	Aconite (turns violet)	Strychnine (straw- colored) Brucine (see above)	Aconitine Codeine (turns green then blue)	...	...
Green	Codeine (brownish)	Aconite (yellowish, cold)	Apomorphine Cocaine (turns blue) Quinine	Cocaine (bluish)	Quinine
Blue	...	...	Codeine Cocaine (from green) Morphine (from all colors)	...	Morphine (from white) Strychnine
Violet	...	...	Morphine (then turns all colors)	Strychnine (to rose on adding $NH_4OH$ ; slow changes)	...
Brown	Aconite Atropine (warm)	...	...	Codeine (from olive)	...
Colorless	Caffeine Cocaine Quinine Strychnine None	Atropine Caffeine Cocaine Codeine Quinine None	Atropine Nicotine Strychnine None	Aconite Atropine Caffeine Quinine None	Aconite Atropine Cocaine Codeine None

\* Frohde's reagent: 0.2 gram molybdic acid in 100 cc. concentrated  $H_2SO_4$ .

† Mandelin's reagent: 1 gram ammonium vanadate in 100 cc. concentrated  $H_2SO_4$ .

(1-2 milligrams) of unknown material is placed in the spot plate and a drop of the reagent is allowed to run down the side of the depression into the material. The spot should be observed for at least five minutes unless otherwise indicated in the table. Color reactions marked with a  $\times$  are not characteristic and may be omitted from the procedure. After the tentative identification of a narcotic, a second

TABLE 3B. NARCOTIC COLOR REACTIONS \*

NARCOTIC	FROHDE'S REAGENT	FERRIC CHLORIDE	HOSHIDA'S REAGENT	MANDELIN'S REAGENT
Codeine	Green to blue	No change	Purple with green	Green to blue
Levorphanol (Dromoran)	Blue	Yellow	Blue to greenish gray	Pale brown
Dihydromorphine (Dilaudid)	Blue to pale green to colorless	Blue	Blue to gray	Pale brown $\times$
Acetylsalicylic acid (aspirin)	Blue to purple to colorless	No change	Blue with red	Green to green brown
Morphine	Red to purple to olive	Blue	Purple	Brown $\times$
Diacetylmorphine (heroin)	Red to purple to olive	No change	Red to purple	Brown $\times$
Methadone (Adanon)	No change	No change	Orange to rust to green (about 20 minutes)	Blue
Alphaprodine (Nisentil)	No change	No change	Red to brown	Pale green
Meperidine (Demerol, Dolantin, Isonipecaïne)	No change	No change	Orange to green to blue (about 15-20 minutes)	Red orange to yellow
Amphetamine (Benzedrine)	No change	No change	Orange to green	Green

\* After R. F. Lampe, *J. Chem. Education* (1957)

sample should be tested along with a known pure sample of the same narcotic.\*

### SYMPTOMS

There are times when it is exceedingly difficult to identify a poison through the symptoms it produces, because the symptoms may closely resemble those produced by a certain illness. For example, peritonitis, an acute indigestion, or intestinal obstruction produces symptoms resembling those of an irritant poison. The symptoms of apoplexy, epilepsy, or cerebral hemorrhage simulate those of narcotic poisoning. Opium poisoning may be mistaken for apoplexy, and strychnine poisoning for tetanus.

One may properly be suspicious when an individual apparently in good health suddenly exhibits marked pathological symptoms that speedily become extreme. There are no definite and established rules to determine poisoning except by chemical analysis of the vomitus, feces, urine, or of the food present or suspected.

Certain general symptoms suggest the possibility of a number of poisons, without definitely establishing any specific one. The following items should be closely observed:

1. Sudden death: Some poisons act swiftly. Tie a string firmly around the patient's finger; the tip of the finger becomes purple if the patient is living.
2. Eyes: General vision impaired, pupils contracted or pupils dilated.
3. Breath: The odor of the poison.
4. Mouth: Dry, or wet (saliva runs), or bleached.
5. Skin:
  - a. Dry.
  - b. Rash.
  - c. Cyanosis—blue skin caused by insufficient oxygen as a result of shallow breathing. Suspect lead compounds, corrosives, or poisonous foods.
  - d. Tissue damage. Suspect strong acids or alkalis. When strong

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\* Under the regulations of the Bureau of Narcotics of the U. S. Treasury Department, persons engaged in research, instruction, or analysis of narcotics (Class VI) may obtain samples of narcotics under the provisions of the Narcotic Act 26 U.S.C. 3220(e). Civil officers may obtain samples of narcotics under the provisions of the act, 26 U.S.C. 3222. Information concerning application forms may be obtained from The Commissioner of Narcotics, Washington, D.C.



acids or alkalies are swallowed, the vomitus is brown or black matter, mixed with blood. Portions of mucous membranes of the stomach are usually present in the vomitus.

6. Nausea, vomiting, or diarrhea: from gastro-intestinal irritants. Suspect metals or poisonous foods.
7. Other reactions of the patient:
  - a. Stupor. Induced by narcotics or alcohol.
  - b. Delirium.
  - c. Paralysis.

Table 4 lists the poisons that are associated with these symptoms.

**TABLE 4. SYMPTOMS OF COMMON POISONS**

**1. SUDDEN DEATH**

Aconite	Cocaine	Oxalic acid
Ammonia (concentrated)	Cyanides	Phenol
Barium compounds	Ether	Strychnine
Carbon dioxide	Hydrogen sulfide	Certain poisons in large dose
Chloral hydrate	Nicotine	

**2. EYES**

<i>General Vision Impaired</i>	<i>Pupils Contracted</i>	<i>Pupils Dilated</i>
Camphorated oil	Barbital	Aconite
Camphoric acid	Chloral hydrate	Aconitine
Ergot	Morphine	Atropine
Foods (at times)	Mushrooms (at times)	Barbital
Lead salts	Nicotine (first stage)	Belladonna
Mushrooms (at times)	Opium	Chloroform (liquid)
Thallium salts		Cocaine
		Hydrogen sulfide
		Iodine
		Nicotine (later stage)
		Opium
		Sodium nitrite
		Wood alcohol

**3. BREATH ODORS**

Acetic acid (vinegar)	Chloroform	Iodine
Ammonia	Cresols	Laudanum
Camphor	Cyanides (bitter almonds)	Phosphorus
Chloral (bananas or pears)	Ether	Thallium salts

## 4. MOUTH

<i>Dry</i>	<i>Wet</i>	<i>Bleached</i>
Atropine	Anything that destroys the membranes of the mouth, e.g., ammonia, arsenic, etc.	Aconite (numb)
Belladonna		Ammonia (flakes)
Opium		Mercury bichloride
		Nitric acid (yellow or white, soft)
		Phenols or cresols (hard, white)
		Potassium carbonate
		Sodium carbonate

## 5. SKIN

<i>Dry</i>	<i>Rash</i>
Aconite	Antimony (like smallpox, rare)
Alcohol	Arsenic (like eczema or scarlet fever)
Antimony	Belladonna (like scarlet fever rash)
Nicotine	Chloral hydrate (urticaria, hives)
Most poisons during the stage of collapse	Croton oil
	Opium (itching, rose patches, rare)
	Turpentine

*Cyanosis (Skin and Lips Blue)*

Acetanilid	Antipyrine
Aniline dyes	Phenacetin

All substances listed below under item 6

*Tissue Damage*

Acetic acid	Hydrofluoric acid
Ammonia water	Lysol
Carbolic acid (white to brown)	Nitric acid (yellow)
Chlorine water	Oxalic acid
Creolin	Phosphoric acid
Creosote	Phosphorus
Cresol	Potassium hydroxide
Croton oil	Sodium hydroxide
Formaldehyde solution	Sulfuric acid (white to brown)
Hydrochloric acid (yellow)	Turpentine

## 6. NAUSEA—VOMITING—DIARRHEA

All acids and alkalis	Antimony compounds (white, stringy, bloody vomitus)
Aconite	Apomorphine
Alcohol (diarrhea at times)	Arnica
Ammonium hydroxide (bloody vomitus)	Arsenic (brown, bloody vomitus)

## 6. NAUSEA—VOMITING—DIARRHEA—CONTINUED

Barium salts	Iodine
Bismuth	Lead compounds
Calcium hydroxide	Mercury
Camphorated oil	Mushroom poisoning
Chlorine water	Opium
Chloroform	Phosphorus (green brown vomitus, luminous in dark)
Copper salts	Picric acid
Corrosive sublimate (green, bloody stools)	Potassium chlorate
Cresols	Potassium carbonate
Croton oil	Potassium hydroxide
Digitalis (grass green vomitus)	Silver nitrate
Ergot	Sodium fluoride
Food poisoning	Sodium hydroxide
Formaldehyde solution	Thallium salts
Gasoline	Turpentine
Hydrogen sulfide	Zinc salts

## 7. OTHER REACTIONS

*Stupor*

Acetanilid	Chloroform
Aconite	Codeine
Aconitine	Ether
Alcohol *	Formaldehyde solution
Allonal	Gasoline
Aminopyrine	Heroin
Amytal	Medinal
Aniline dyes	Morphine
Antipyrine	Opium
Apomorphine	Paraldehyde
Atropine	Phenacetin
Barbiturates	Phenobarbital
Belladonna	Sulfonal
Bromides	Trional
Chloral hydrate	Turpentine

*Delirium*

Alcohol	Camphor
Belladonna (happy, noisy)	Stramonium

\* Do not confuse a fractured skull or concussion with alcoholic poisoning. There have been instances where an individual who was thought drunk was lodged in a local jail, and only later upon examination was found to be suffering actually from a fractured skull or a concussion.

Aconite  
Arsenic

*Paralysis*  
Lead

## EMERGENCY TREATMENT

*Send for a physician at once. Make this your first and most important duty.*

Get in touch with the poisoning control center of your municipality or your local health department. A number of cities have agencies; for instance the Department of Health of the City of New York, the Boston Poison Information Center, the Chicago Poisoning Control Center, the Duke Hospital Poison Control Center of Durham, N. C., and some counties and states, like Nassau County in Long Island and the New York State Department of Health, maintain such units.

## MEASURES TO BE TAKEN BEFORE THE ARRIVAL OF A PHYSICIAN

The following steps have been recommended in the *Journal of the American Medical Association*, Volume 165, Oct. 12, 1957, by the American Medical Association as proper in the case of a suspected poisoning.

### I. SWALLOWED POISONS

Many products used in and around the home, although not labeled poison, may be dangerous if taken internally. For example, some medications which are beneficial when used correctly may endanger life if used improperly or in excessive amounts.

In all cases, *except those indicated below, remove the poison from the patient's stomach immediately* by inducing vomiting. This cannot be overemphasized, for it is the essence of the treatment and is often a lifesaving procedure. Prevent chilling by wrapping patient in blankets if necessary. Do not give alcohol in any form.

#### A. Do Not Induce Vomiting If:

1. Patient is in a coma or unconscious.
2. Patient is in convulsions.
3. Patient has swallowed petroleum products (i.e., kerosene, gasoline, lighter fluid).
4. Patient has swallowed a corrosive poison (symptoms: severe pain, burning sensation in mouth and throat, vomiting).

*Call a physician immediately*

- (a) Acid and acid-like corrosives: sodium acid sulfate (toilet bowl cleaners), acetic acid (glacial), sulfuric acid, nitric acid, oxalic acid, hydrofluoric acid (rust removers), iodine, silver nitrate (styptic pencil).
- (b) Alkali corrosives: sodium hydroxide-lye (drain cleaners), sodium carbonate (washing soda), ammonia water, sodium hypochlorite (household bleach).

If the patient can swallow after ingesting a *corrosive poison*, the following substances (and amounts) may be given:

For acids: milk, water, or milk of magnesia  
(1 tablespoon to 1 cup of water).

For alkalis: milk, water, any fruit juice, or vinegar.

For patient 1-5 years old—1 to 2 cups.

For patient 5 years and older—up to 1 quart.

***B. Induce Vomiting When Noncorrosive Substances Have Been Swallowed:***

- 1. Give milk or water (for patient 1-5 years old—1 to 2 cups, for patient over 5 years—up to 1 quart).
- 2. Induce vomiting by placing the blunt end of a spoon or your finger at the back of the patient's throat, or by use of this emetic—2 tablespoons of salt in a glass of warm water.

When retching and vomiting begin, place patient face down with head lower than hips. This prevents vomitus from entering the lungs and causing further damage.

## II. INHALED POISONS

- 1. Carry patient (do not let him walk) to fresh air immediately.
- 2. Open all doors and windows.
- 3. Loosen all tight clothing.
- 4. Apply artificial respiration if breathing has stopped or is irregular.
- 5. Prevent chilling (wrap patient in blankets).
- 6. Keep patient as quiet as possible.
- 7. If patient is convulsing, keep him in bed in a semidark room; avoid jarring or noise.
- 8. Do not give alcohol in any form.

## III. SKIN CONTAMINATION

- 1. Drench skin with water (shower, hose, faucet).
- 2. Apply stream of water on skin while removing clothing.



3. Cleanse skin thoroughly with water; rapidity in washing is most important in reducing extent of injury.

#### IV. EYE CONTAMINATION

1. Hold eyelids open, wash eyes with gentle stream of running water *immediately*. Delay of few seconds greatly increases extent of injury.
2. Continue washing until physician arrives.
3. *No not use chemicals*; they may increase extent of injury.

#### V. INJECTED POISONS (scorpion and snake bites)

1. Make patient lie down as soon as possible.
2. Do not give alcohol in any form.
3. Apply tourniquet above injection site (e.g., between arm or leg and heart). The pulse in vessels below the tourniquet should not disappear, nor should the tourniquet produce a throbbing sensation. Tourniquet should be loosened for 1 minute every 15 minutes.
4. Apply ice pack to the site of the bite.
5. Carry patient to physician or hospital; *do not let him walk*.

#### VI. CHEMICAL BURNS

1. Wash with large quantities of running water (except burns caused by phosphorus).
2. Immediately cover with loosely applied clean cloth.
3. Avoid use of ointments, greases, powders, and other drugs in first-aid treatment of burns.
4. Treat shock by keeping patient flat, keeping him warm, and reassuring him until arrival of physician.

#### MEASURES TO PREVENT POISONING ACCIDENTS

- A. Keep all drugs, poisonous substances, and household chemicals out of the reach of children.
- B. Do not store nonedible products on shelves used for storing food.
- C. Keep all poisonous substances in their original containers; *do not* transfer to unlabeled containers.
- D. When medicines are discarded, destroy them. Do not throw them where they might be reached by children or pets.

- E. When giving flavored and/or brightly colored medicine to children, *always* refer to it as medicine—*never* as candy.
- F. Do not take or give medicine in the dark.
- G. *Read labels* before using chemical products.

## MEASURES THAT MAY BE TAKEN BY THE PHYSICIAN

Gettler and Freireich (*Postgraduate Medicine*, Volume 15, No. 4, 1954) have summarized the measures that may be taken by a physician in the more common instances of poisoning by poisons taken orally.

### GENERAL PROCEDURE

1. If poison is not known, give 15 gm. of universal antidote in one-half glass of warm water. (Activated finely divided charcoal 2 parts, tannic acid 1 part, magnesium oxide 1 part) If universal antidote is not available, or if the specific chemical antagonist (see below) is not available, large quantities of milk and eggs may be used. If poison is known, see specific antidotes (below).

2. Induce vomiting by stroking back of tongue from side to side, or by giving plenty of warm salt water, or by washing stomach by means of tube. Avoid these procedures where a corrosive poison has been swallowed to prevent rupture of stomach or esophagus.

3. Administer a cathartic (an ounce of magnesium sulfate in copious amounts of water), and flush bowel by high colonic irrigation with warm water.

### SPECIFIC ANTIDOTES

**Acids (Strong).** Give large quantity of milk of magnesia. Do not give bicarbonate; do not induce vomiting; do not use stomach tube. Follow from time to time with milk or white of eggs beaten with water.

**Oxalic Acid.** Administer lime water. Do not give bicarbonate. Then follow general procedure 3.

**Alcohol (Wood).** General procedures, 2 and 3, then intravenous 3 to 5% bicarbonate solution with 5% glucose. If the patient is conscious, give bicarbonate orally; ethyl (grain) alcohol is also beneficial (50 ml. every four hours).

**Alkalies.** Give large quantity of 1% acetic acid solution or vinegar in a proportion of 1 to 4. Do not induce vomiting. Do not use stomach tube. Follow with milk and white of eggs beaten in water.

**Alkaloids.** General procedures 1, 2 and 3. *For strychnine:* Do not induce vomiting and keep patient quiet. *For morphine group:* N-Allylnormorphine intravenously, 5 to 10 mg. and repeat in 10 to 15 minutes; as much as 40 mg. may be given.

**Arsenic.** General procedures 1, 2 and 3; then BAL in repeated intramuscular doses of 2.5 mg. per kilogram.

**Barbiturates.** Benzedrine (amphetamine) 40 mg., intravenously, then 20 mg. every half hour until signs of recovery appear. Also infusion of 5% glucose in saline, then glucose alone. Do not use tracheal intubation or bronchoscopy; use postural drainage to remove accumulated secretions.

**Barium Salts.** Two tablespoons of magnesium sulfate in a glass of warm water; then general procedures 2 and 3, followed by milk or white of eggs.

**Bromate, Bromine, Chlorate, Iodine.** One tablespoon of sodium thiosulfate in glass of water or starch solution, then general procedures 2 and 3 followed by milk of magnesia, 30 cc. in water.

**Cyanides.** Act fast. If the patient is conscious, induce vomiting by giving warm salt water (1 tablespoon in glass of water). Have the patient inhale amyl nitrite for 15 seconds and repeat five times at 30-second intervals. Then, intravenously, give 10 cc. of 3% sodium nitrite and 50 cc. of 25% sodium thiosulfate solution.

**Essential Oils.** 120 cc. of liquid petrolatum; then general procedures 2 and 3, followed by milk and eggs.

**Fluorides, Sodium Fluoroacetate (1080), Hydrofluoric Acid.** Glassful of lime water, or 1% calcium chloride solution; then wash with plenty of water. Intravenously: Pentobarbital, 15 to 20 mg. per kilogram of body weight; intracardiac injection of procaine for ventricular fibrillation.

**Formaldehyde.** Milk freely or 1 tablespoon ammonium acetate in glass of water; induce vomiting with salt water, then milk and eggs.

**Lead (Acute).** Magnesium sulfate, 20 gm. to 1 oz. of water; then general procedures 2 and 3, followed by egg white and milk.

**Lead (Chronic).** Sodium calcium versenate (Versene) in glucose solution by slow venous drop. The maximum concentration should not exceed a 3% solution. The dose in a one-hour period must not exceed 0.5 gm. for every 30 pounds of body weight. The total daily



dose is not to be more than 1 gm. per 30 pounds of body weight. Total dosage for a week must not exceed 5 gm. per 30 pounds of body weight. After one week of this treatment, allow one week of rest period; then repeat the treatment.

**Mercury.** A glass of 5 to 10% sodium phosphite solution or sodium formaldehyde sulfoxalate solution; then general procedures 2 and 3; then BAL intramuscularly.

**Organic and Fluorophosphates, Parathion E605.** Large quantity of milk; induce vomiting, perform artificial respiration, then, intramuscularly,  $\frac{1}{30}$  grain atropine sulfate every hour until recovery is noticed.

**Phenols.** Vomiting by salt water, then large quantities of milk or white of eggs; no oils or alcohol.

**Phosphorus.** Wash stomach with 2% copper sulfate solution or 1% potassium permanganate solution several times; then general procedure 3.

**All Other Poisons or Drugs.** General procedures 1, 2 and 3.

*After preliminary treatment as described above, symptomatic treatment may be required.*

## SPECIAL EMERGENCY TREATMENTS

**Gas.** If the poison is a gas, the immediate need is fresh air and artificial respiration. If an inhalator is available it should be used in conjunction with artificial respiration to supply a greater concentration of oxygen, plus 5% to 7% of carbon dioxide, which is the mixture usually found in the inhalator tanks. When the patient revives keep him quiet and warm. See page 224.

**External Burns.** If the poisoning is external—e.g., a burn on the hand from concentrated acid—the poison is to be washed with (1) plenty of water, or (2) if not water-soluble, with soap and water, or (3) with alcohol. Then the remaining poison is neutralized: (1) If it is an acid burn, wash with milk of magnesia, lime water, chalk, whiting, sodium bicarbonate, much soap and water (page 10). (2) If it is an alkali burn, wash with lemon or other citrus juice (citric acid), or with vinegar (acetic acid).

**Poison from Bite or Injection.** If the poison has come from a bite or an injection, the poison can sometimes be checked from spreading

throughout the body by properly applying a tourniquet or a constricting band tightly above the wound. This retards the absorption of the poison by the blood. The poison may be removed by sucking, if the operator has no cuts in the mouth. *Note: When using a restricting band, take care to loosen it every 15 minutes for about one minute to prevent gangrene.* The poison may also be destroyed chemically; for example, formic acid in ant stings is neutralized by applying ammonia water.

**Poisoning by Swallowing.** By far the majority of poisons, however, will have reached the stomach. Treatment in this case follows the steps:

1. *Send for a physician at once.*

2. *Emetics to Produce Copious Vomiting.* This operation removes the bulk of the poison.

3. *Antidotes.* Chemicals are used to destroy any poison still remaining in the stomach. Since the antidote itself may be poisonous, and often cannot be left in the stomach, the antidote is added to the washing solution if an emetic is used. The antidote solution is swallowed between the intervals of vomiting. (See page 32.)

4. *Demulcents.* Substances like milk or oatmeal gruel, which form a soothing, protective coating over the irritated membranes.

5. *Special Treatments.* Keep the patient warm and quiet, elevate the feet, give a stimulant (indicated under each poison). Eventually cathartics may be given to remove poisons which have already gone into the intestines; generally by this time the physician will have arrived.

Each of these steps will be taken up in turn in the following paragraphs.

**Send for the Physician.** It is well to remember when sending for a physician to give the exact location where the victim can be found. It may also be beneficial to inform the doctor what the injury is, and if you know, what type poison was taken.

**Emetics.** Emetics are medicines or substances that produce vomiting. In this way the poison is washed out of the stomach. The sooner the emetic is given, the better the results will be; and even though several hours have elapsed it is still wise to give an emetic, since some poisons are not readily absorbed. *Avoid emetics if strong acids or*

*alkalies have been taken, since vomiting may rupture the already damaged walls of the stomach and esophagus.*

It must be emphasized that a single vomiting does not clear the stomach; *the vomiting must be repeated several times.* Induce vomiting repeatedly until the vomitus fluid is clear. If vomiting does not occur after the emetic has been given, tickle the throat. If the patient resists feeding the emetic, place your two thumbs inside his throat (so he cannot bite), depress the tongue with the handle of a spoon, and force-feed. It must be remembered that vomiting is more easily induced and more effective when the stomach is filled with liquid; hence the old first-aid dictum for poisoning treatment may be stressed: (1) *Dilute* and (2) *wash out*. Such dilutions with large quantities of lukewarm liquids if available also slow absorption; if salt water or soapy water is given, both objectives are accomplished simultaneously.

Some common emetics follow

1. *Dry mustard.* 1 teaspoonful of dry mustard in 1 glass of lukewarm water, give about  $\frac{1}{4}$  of this amount and follow with a glass of warm water. Repeat this same procedure again in 1 minute. Continue until the entire glass has been given.

2. *Salt.* 2 tablespoonfuls of salt in 1 glass of lukewarm water. Repeat, giving a glass of warm salt water every minute until 4 glassfuls have been given.

3. *Soapy water.* Shake a piece of mild soap in a bottle of warm water to make suds. Give about  $\frac{1}{4}$  of a glassful, and follow with a glassful of warm water. Continue until 4 doses have been taken.

4. *Zinc sulfate (white vitriol)* Dissolve about 20 grains (about as much as can be heaped on a 25-cent piece) in a glass of water. Have the patient drink this, followed by a cup of warm water. Repeat until 3 doses (total 60 grains, no more) have been given. Do not use when the poison taken is an irritant poison.

5. *Pulverized ipecac (ipecacuanha)* Good for children. Mix 20 grains with 1 cup of water; it will form solid particles suspended in water, like mustard. Give a total of 3 glassfuls (total 60 grains, no more).

6. *Tickling the throat.*

7. *Copper sulfate.* Dissolve  $\frac{1}{2}$  gm. in 1 glass of warm water. Have the patient drink this, followed by a glass of warm water. Repeat in 15 minutes until 3 doses have been taken. Do not use when the poison taken is an irritant poison.

**Antidotes.** An antidote neutralizes the action of a poison either by altering its physical state or its chemical composition, thereby preventing its action or retarding its absorption. The compounds formed by antidotes are very often only slightly less toxic than the original poison, or they may become poisonous by remaining in the stomach. Therefore, *antidotes should be a part of the lavage or given with the emetics.* When emetics are employed, the antidotes may be given between the intervals of vomiting. Generally, antidotes are given repeatedly at short intervals. Tannin is one of the most valuable antidotes and acts as a precipitating agent. Tannin may be given in the form of very strong hot tea.

**Antidotes for Specific Poisons.** Following are a few antidotes that are useful against specific poisons:

<i>Acids</i> .....	Baking soda, soap, burnt magnesia, chalk
<i>Alkaloidal poisons</i> ....	About 15 drops of tincture of iodine in 1/2 glass of water
<i>Alkalies</i> .....	Vinegar or lemon juice
<i>Barium</i> .....	Magnesium sulfate (Epsom salts)
<i>Glucosides</i> .....	Potassium permanganate, sodium acetate
<i>Oxalates</i> .....	Lime water, whiting, or chalk
<i>Phosphorus</i> .....	Copper sulfate

**Universal Antidote** consists of 2 parts of activated charcoal, 1 part of magnesium oxide, and 1 part of tannic acid mixed together. This is given as 1/2 ounce (15 gm.) in half a glass of warm water and may be used to absorb or neutralize poisons. Universal antidote is considered useful in poisoning attributable to acids, alkaloids, glucosides, and heavy metals. After administration it is to be followed by washing out the stomach, except after poisoning by corrosive substances.

**Multiple Antidote.** A good multiple antidote to have handy is a saturated solution of sulfate of iron 100 parts, water 800 parts, magnesia 88 parts, animal charcoal 44 parts. It is best to have magnesia and animal charcoal mixed together in the dry state and kept in a well corked bottle. When required for use the saturated solution of iron is mixed with eight times its bulk of water and the mixture of charcoal and magnesia added with constant stirring. Give in nine glass doses. It is effective against arsenic, zinc, opium, digitalis, mercury, and strychnine, but not against phosphorus, alkalies, or antimony.

**Physiological Antidotes.** This class of antidotes may merely mask

the symptoms produced. Used against absorbed poisons, they tend to combat the symptoms by arousing an opposite action. They very often carry the patient over the critical period and aid in preserving life. Following are some examples:

Atropine for morphine  
 Atropine for organic phosphorus insecticides (parathion, malathion)  
 Atropine for pilocarpine  
 Barbiturates for cocaine  
 Caffeine for morphine  
 Chloroform for strychnine

*The use of physiological antidotes is strictly limited to the physician alone.*

*Antidote Kit.* The following materials are suggested to meet poison emergencies. The kit is suggested *for use by the physician*, each container having the dose carefully written on the label.

Ammonium carbonate	Limewater
Amyl nitrite pearls	Magnesia (calcined)
Antihistamine tablets	Morphine sulfate tablets (10 mg.)
Apomorphine tablets (2 mg.)	Olive oil
Atropine syrets (2 mg)	Potassium permanganate (1% aq. sol. to be diluted 20 times)
BAL (Dimercaprol)	Sodium bicarbonate
Botulism antitoxin	Sodium chloride
Caffeine-sodium benzoate	Sodium sulfate
Calcium gluconate	Aromatic spirits of ammonia
Calcium lactate	Strychnine sulfate tablets (2 mg.)
Castor oil	Universal antidote
Powdered animal charcoal	Whiskey
Chloroform	Hypodermic syringes
Cocaine hydrochloride tablets (0.03 gm)	Stomach tube or gastric lavage equip- ment
Epinephrine tablets (1 mg)	Tourniquet
Tincture iodine (7%)	Funnel
Cupric sulfate (powdered)	

The following can be secured at the site where the poisoning occurred: boiled water; hot, strong, black coffee; eggs; heat applications such as water bottles, etc.; milk; mustard; salt; soap; starch; tea; vinegar.

Demulcents have a soothing effect on inflamed membranes. They are usually given after most of the poison has been removed or counteracted. The following demulcents are suggested:

Milk  
Whites of eggs  
Flour paste  
Flaxseed tea  
Elm bark tea

Gelatin solution  
Gum arabic solution  
Oatmeal gruel  
Cream of Wheat

If the stomach tissues are injured, cool the demulcents before feeding.

### SPECIAL TREATMENTS

Cathartics induce bowel movement. *If adominal pains are present cathartics should not be used because the pains may be caused by appendicitis.* Cathartics are seldom used, since the poison is best brought out by way of the mouth. If the poison has been swallowed several hours before first aid is administered, or if the poison is quickly absorbed, the physician may recommend the use of cathartics. (Laxatives, milk of magnesia, mineral oil, and agar-agar are often used.)

The form in which the poison is eventually eliminated varies considerably. For example wood alcohol is excreted as formic acid within a few days; on the other hand ethyl alcohol is oxidized and eliminated from the body as carbon dioxide and water within 24 hours. Mercury bichloride is taken up by the white blood cells, chiefly in the liver and kidneys, and appears in the urine and feces within a few hours to two weeks after ingestion. Carbon monoxide remains in the blood and muscles for several hours.

Stimulants increase the activity of the heart and the nervous system. *Do not give stimulants to persons sustaining head injuries, internal injuries, or excessive bleeding. Alcoholic beverages are not good stimulants.* For some poisons there are certain stimulants that should be carefully avoided, for they produce bad effects; these cases are noted under each poison in the next chapter. Otherwise generally useful stimulants are:

Aromatic spirits of ammonia (1 teaspoonful in  $\frac{1}{2}$  glass of water)  
Strong, hot, sweetened coffee or tea

Analgesics and sedatives are preparations that induce sleep and relieve pain. *Unless prescribed by a physician, analgesics and sedatives should be avoided,* as many of these preparations are habit-forming. Aspirin tablets (5 grain) are helpful, and are not considered habit-forming.

## SPECIAL PROPERTIES OF POISONS

### GENERAL INFORMATION, CHEMICAL IDENTIFICATION, SYMPTOMS, AND EMERGENCY TREATMENT

Because this book is intended for use during an emergency, it is desirable to give specific and practical information about individual poisons. A similar pattern is followed in characterizing and describing each poison. The pattern follows four main topics:

1. *General information* covering, in the order mentioned, name, formula, other names for the same substance, physical appearance, industrial preparation and use, medical use, normal medicinal dose, and fatal dose. The most common name is given first. Acids and alcohols are listed under A, that is Acid, Hydrochloric; Acid, Sulfuric; Alcohol, Ethyl; Alcohol, Methyl. Refer to the index at the back of this book if you do not immediately locate the name of the poison you suspect. Fluorides, for example, will be found both under Acid, Hydrofluoric and Sodium Fluoride.

2. *Identification* by chemical means.

3. *Symptoms*: identification by physiological means.

4. *Emergency treatment*: first aid before the physician arrives.

**Remember: Call a physician immediately. Get in touch with your Poisoning Information Center.**

Acetanilid ( $C_6H_5NHCOCH_3$ ), acetaminobenzene, acetylaniline, antifebrin, or phenylacetamide is colorless, odorless, crystalline scales or powder, with a slightly pungent taste. It is produced by boiling aniline with glacial acetic acid for several hours; the crystalline mass resulting from this process is then distilled. It is used in manufacturing medicinals and dyes, in stabilizing hydrogen peroxide, and in varnishes.

Acetanilid is used principally to relieve neuralgic and muscular pains, or to reduce temperature in mild fevers; also as a dry powder, with or without boric acid, for antiseptic dressings.

Most poisonings from acetanilid are accidental. The average dose is 3 grains, or 0.2 gm.; the fatal dose is difficult to determine; 10 to 20 grains may kill a person with a weak heart, whereas a person with a normal heart may survive a dose up to 30 grains. Death may be sudden or the victim may linger for several days.

*Identification.* *p*-Aminophenol is found in the urine the morning after repeated doses of acetanilid have been taken. Extracted with ether. TEST 1. (a) Conc. HCl; (b) fresh aq. solution of chloride of lime; (c) aq. potassium permanganate; (d) aq. 5% sodium nitrate; (e) dil. sodium hydroxide; (f) 5% beta-naphthol in ethyl alcohol. Treat unknown with (a), then dilute with water. Separate into three portions, and test as follows: Portion 1: Let 1 cc. of (b) run gently down the side of the tube. Blue color at the juncture shows acetanilid. Portion 2: Add 1 cc. of (c). Green shows acetanilid. Portion 3: Add a few drops (d); make alkaline to litmus paper with (e), and then add a few drops of (f). Red basic azo dye shows acetanilid. (See Phenacetin tests.) TEST 2. (g) Chloroform; (h) dil. potassium hydroxide. Gently heat 2 cc. of unknown + 2 cc. of (g) + 2 cc. of (h). The offensive odor of phenylisocyanide indicates acetanilid and other aniline derivatives.

*Symptoms.* Nausea and vomiting; cyanosis (face and hands blue); slow, feeble pulse; subnormal temperature; mental sluggishness; stupor; collapse.

*Treatment.* Give universal antidote. Wash out the stomach with 240 cc. (8 oz.) of potassium permanganate solution (1:1000) or use an emetic of Epsom salts. Give hot tea or coffee. Administer oxygen containing 5% carbon dioxide to relieve the cyanosis, and apply artificial respiration if necessary. Keep the patient warm, quiet, and in a recumbent position.

*Other Poisons.* Acetophenetidin, aminopyrine, aniline dyes and inks, antipyrine, and phenacetin call for the same treatment as for Acetanilid.

Acid, Acetic ( $\text{CH}_3\text{COOH}$ ) is a colorless, pungent organic acid, 100,000 tons of which are manufactured each year by catalytically adding water to acetylene to form acetaldehyde, followed by oxidation with



air. A second method is the distillation of wood, a crude acetic acid being produced from the pyroligneous acid resulting from this wood distillation; this is one source of acetic anhydride, from which acetate plastics, airplane dopes, cellulose acetate rayon, moving picture safety film, etc. are made in enormous tonnages. Acetic acid is also widely used in rubber coagulation, in the textile dyeing and printing trades, for gums and resins, as a solvent for many organic compounds, and in the manufacture of acetate chemicals.

A solution containing about 99.5% (over 99%) acetic acid in water is called *glacial acetic acid* because it freezes to an icelike or glacier-like solid just below room temperature. This concentrated acid is used by some physicians to destroy warts. Glacial acetic acid causes severe burns upon contact with the skin.

A *very dilute* solution (6% acetic acid) is used by some physicians as a cooling drink to relieve thirst from fever, or in fever-cooling lotions.

By law, vinegar, which is made by the fermentation of cider, must contain over 4 gm. of acetic acid per 100 gm. of vinegar (actual content varies between 4% and 5%). Since acetic acid is a weak acid, and since vinegar is only a dilute solution of this weak acid, ordinary household vinegar is a most useful acid for neutralizing alkalis that have been accidentally swallowed (see page 10).

The average dose of the 6% solution is 30 minims, or 2 cc. Two tablespoonfuls of glacial acetic acid has caused death of an adult. Death occurs in a few hours.

*Identification.* The odor of vinegar identifies acetic acid.

*Symptoms.* Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, or convulsions; collapse.

*Treatment.* If concentrated acids have been swallowed, avoid the use of emetics, stomach pump, or carbonates (that is, avoid chalk, whiting, or baking soda), the carbonates react with the acid to give a violent evolution of carbon dioxide gas, which may further damage the injured stomach tissue. Neutralize the acid with an alkali such as limewater, milk of magnesia, or soapsuds. However, if dilute acid has been swallowed, chalk or bicarbonates may be used. Have the victim swallow plenty of water to help dilute the acid. Give raw eggs

and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

*External Treatment.* Wash with an abundance of water, and apply a paste made with water and baking soda, or water and chalk; finally wash off again with quantities of water.

**Acid, Boric, or Boracic Acid.** These names commonly refer to orthoboric acid ( $\text{H}_3\text{BO}_3$ ), which has been obtained for a hundred years by condensation and crystallization of hot gases from volcanoes in Italy. The acid is obtained also by treating borax ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ) with hydrochloric acid. Boric acid forms white, thin, lustrous flakes. Borax, of great importance in making Pyrex brand glass, is a familiar cleaner and water softener about the home.

Externally boric acid is used in ointments and dressings for burns, cuts, and skin diseases; in a 1 to 4% solution as an eye wash; and in a 2 to 4% solution as an irrigant. The chief danger is in mistaking boric acid for sugar, in making up an infant's milk formula. One to 2 gm. per day may result in serious symptoms.

*Identification.* Borates are found in the urine. (a) Aq.  $\text{NaNO}_2$ ; (b) aq.  $\text{Na}_2\text{CO}_3$ ; (c) ethyl alcohol. Evaporate urine to near dryness; then add 1 cc. of (a) + 1 cc. of (b). Heat to dryness. Mix the residue with 2 cc. of (c) and burn. A green flame indicates boron as volatile  $(\text{C}_2\text{H}_5)_3\text{BO}_3$ .

*Symptoms.* Nausea, vomiting, diarrhea, headache, cold sweat, sub-normal temperature, rash, weak heart, collapse.

*Treatment.* Halt the use of boric acid. If the poisoning is acute, summon a physician. Wash out the stomach with an emetic; give hot coffee or milk as a stimulant. Avoid baking soda. Keep the patient warm and quiet.

**Acid, Camphoric.** See Camphor.

**Acid, Carbolic.** See Phenol. This is not really an acid; the name is misleading. It should not receive the general first-aid treatments given for acids.

**Acid, Hydrochloric ( $\text{HCl}$ ), chlorhydric acid, muriatic acid, or spirit of salt** is sold chiefly as an aqueous solution containing about 38%  $\text{HCl}$ . This solution has a pungent odor and fumes; it gives off white smoke if a bottle of ammonium hydroxide is brought near. The pure acid is colorless, but the commercial product is often yellowish from traces of iron salts. Hydrochloric acid is produced commercially either

by the combination of hydrogen and chlorine, or by the action of sulfuric acid on common table salt (sodium chloride). The acid is used extensively in the laboratory, in industry to clean metals, in preparing a surface for soldering or plating, and to prepare soluble salts, such as morphine hydrochloride.

*Dilute* hydrochloric acid is prescribed by some physicians for internal use to control stomach acidity and to stimulate digestion in pernicious anemia; and to allay thirst from fever. Externally the acid is a mild astringent in eczema and skin irritations.

Hydrochloric acid is one of the strongest known acids, comparable to nitric acid in chemical action. Most of the poisoning cases from this acid are accidental. A few drops of concentrated acid entering the windpipe may produce death rapidly. Fifteen cc. is considered sufficient to cause death when taken directly into the stomach.

*Identification.* Hydrochloric acid turns blue litmus paper pink. **TEST 1.** (a) Dil.  $\text{NH}_4\text{OH}$ . Open a bottle of (a) brought near the mouth. White smoke fumes of  $\text{NH}_4\text{Cl}$  indicate hydrochloric acid. **TEST 2.** Use unknown diluted with water. (b) Aq. silver nitrate; dil.  $\text{HNO}_3$ . One cc. of aq. unknown + 1 cc. (b) + 1 cc. (c). White precipitate, turns slightly purplish in sunlight = hydrochloric acid or a chloride as  $\text{AgCl}$ .

*Symptoms.* Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst, difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of muscles, or convulsions; collapse.

*Treatment.* Avoid emetics, stomach pump, or use of chalk, white or other carbonates if concentrated acid has been swallowed; this may all injure the damaged tissues.

Neutralize the acid with an alkali such as limewater, soapsuds, milk of magnesia. Give plenty of water to help dilute the acid. Follow with raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient quiet and warm.

*External Treatment.* Wash with abundance of water and apply a paste made with water and baking soda.

**Acid, Hydrocyanic ( $\text{HCN}$ ) or prussic acid** occurs in aqueous solution. Pure hydrogen cyanide is a colorless, inflammable liquid, which boils near room temperature ( $79^\circ \text{F.}$ ). Both the liquid and the aqueous solution have the odor of bitter almonds. The solution, which

weak acid, is manufactured by distilling a concentrated solution of sodium or potassium cyanide with dilute sulfuric acid, and absorbing the vapors in water. The gas may be compressed as pure, liquid hydrogen cyanide containing as warning gases 5 to 10% lachrymators such as chloropicrin, or 20% cyanogen chloride. These are used as fumigants to rid ships and warehouses of rodents and vermin and to fumigate citrus trees. It is not a germicide or bactericide. Cyanide salts are also used in insecticides, for case-hardening steel, and in electroplating solutions.

Hydrocyanic acid is one of the most poisonous substances known; the inhalation of its fumes in high concentration will cause almost immediate death. Hydrogen cyanide acts by preventing the normal processes of tissue oxidation and paralyzing the respiratory center in the brain. Most of the accidental cases are due to inhaling the fumes during a fumigating process. In the pure state it kills with great rapidity. Crystalline cyanides, such as sodium or potassium cyanide, are equally poisonous, since they interact with the hydrochloric acid in the stomach to liberate hydrocyanic acid. This poison has been used both for homicide and suicide; in recent history, a number of European political figures carried vials of cyanide salt for emergency self-destruction and some used them. Deaths resulted from amounts of only a fraction of a gram. A concentration of 1 part in 500 (2.5 mg. per liter) of hydrogen cyanide gas is fatal. Allowable working concentration in most of the United States is 20 ppm. Two and one-half grains of liquid acid has killed. The acid acts fatally in about 15 minutes. The cyanide salts kill in several hours. The average dose of the 2% solution is 1.5 minim or 0.1 cc.

*Identification.* Cyanides produce an odor of oil of bitter almonds on the breath or in vomitus. **TEST 1.** (a) Aq. mercuric chloride solution; (b) 2.5% aq. methyl orange; (c) glycerin. Dip filter paper into a mixture containing 20 cc. of (a) + 10 cc. of (b) + 2 cc. of (c). Dried, this paper will keep a month in airtight, amber vials. Paper held to the mouth will turn pink in 2 minutes (Sherrard reagent). **TEST 2.** (d) Aq. 3% cupric acetate; (e) glacial acetic acid saturated with benzidine (filter by suction). Immediately before using, mix 15 cc. of water + 1 cc. of (d) + 5 cc. of (e); dip filter paper; hold the wet paper to the breath or dip it in vomitus. A blue color in 7 to 10 seconds indicates 20 to 80 mg. hydrogen cyanide per cubic meter.

*Symptoms.* Since this is an extremely rapid poison, rapid action

is necessary. Occasionally the victim may make a few voluntary actions before death results or alarming symptoms set in. Death results from paralysis of the respiration. When a smaller dose is taken the symptoms are dizziness, headache, and shortness of breath, followed by convulsions, coma, and collapse.

*Treatment.* Immediate treatment is necessary to be of value. If amyl nitrite is available, have the victim inhale it immediately for 20 seconds. Have the victim swallow 2 tablespoonfuls of hydrogen peroxide (3% household variety). Wash out the stomach with hydrogen peroxide. Have the victim inhale ammonia. Administer oxygen, and apply artificial respiration immediately if natural breathing has stopped.

*Other Poisons.* Bitter almond oil, cherry laurel water, and other cyanides show the same symptoms and call for the same treatment as Acid, Hydrocyanic.

*Acid, Hydrofluoric (HF)<sub>6</sub>*, fluohydric acid, or hydrogen fluoride occurs mostly as an aqueous solution of the colorless, odorless gas (liquefies at 68° F.). The solution is obtained by treating powdered calcium fluoride with concentrated sulfuric acid, distilling in a retort of lead or platinum, and absorbing the vapor of hydrogen fluoride in water. The acid is stored in wax, guttapercha, rubber, lead or plastic containers, since glass bottles are etched by this extremely corrosive solution. The concentrated acid will fume. The pure liquid, the vapor, and the aqueous solutions are all employed commercially for etching enamelware and glass, for frosting lamp bulbs, in the manufacture of fluorides, for removing sand from metallic castings, and in the laboratory for analysis of silicate rocks. The use of hydrofluoric acid in industry is increasing.

Hydrogen fluoride, as vapor, liquid, or solution, is violently corrosive and extremely dangerous, causing painful skin sores. Most of the poison cases from it are accidental. Two drams has caused death of an adult. A vapor concentration of 3 ppm is the maximum allowable concentration for workers recommended by the American Conference of Governmental Industrial Hygienists.

*Identification.* Hydrofluoric acid or sodium fluoride may be identified by placing the amount to be tested in a shallow container, adding a little concentrated sulfuric acid, and covering the container with a piece of glass (watch crystal). The glass will etch when heat is applied to the container.

*Symptoms.* Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles; convulsions; collapse.

*Treatment.* If much acid has been swallowed, avoid emetics, or carbonates (avoid chalk, whiting, baking soda). Instead, give plenty of water to help dilute the acid. Neutralize the acid with an alkali such as limewater, milk of magnesia, or soapsuds. The stomach may be washed out by a physician, but care should be exercised, since the stomach tube may penetrate the weakened wall of the stomach. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

*External Treatment.* Wash thoroughly with soap and water; and apply a paste of sodium bicarbonate, or chalk and water, or milk of magnesia.

*Other Poisons.* Roach powders or other fluorides are marked by the same symptoms and call for the same treatment as Sodium Fluoride.

Acid, Nitric ( $\text{HNO}_3$ ), aqua fortis, or azotic acid is a heavy, dangerous, corrosive liquid. Commercial concentrated acid contains about 68%  $\text{HNO}_3$ , and is colorless if pure, but is often yellow from nitrogen dioxide, which forms in it on exposure to air and light. The acid is prepared industrially by the catalytic oxidation of ammonia; a small quantity is still prepared by the older process of treating Chile saltpeter ( $\text{NaNO}_3$ ) with concentrated sulfuric acid.

An especially corrosive variety, fuming nitric acid, contains 87 to 92%  $\text{HNO}_3$ , and is deep reddish-yellow from excess nitrogen dioxide dissolved in it; even the reddish-brown fumes from it instantly attack the human tissue.

Nitric acid is a powerful oxidizing agent. With cotton or wood it forms cellulose nitrates, the basis of some nitrate explosives (gun-cotton, nitroglycerin, smokeless powders) and of nitrate plastics (celluloid, pyroxylin film, and lacquers). It also forms nitro-explosives such as picric acid (trinitrophenol) and TNT (trinitrotoluene). Nitric acid is used in producing organic nitrogen compounds, and in the etching, photoengraving, and paper trades. Enormous tonnages go into producing nitrate fertilizers.

Certain concentrations are used externally for warts, snake bites, ulcers, etc. Human tissue and wool form a deep yellow compound

even with the dilute acid. Three fluid drams of the concentrated acid is considered a dose fatal to adults.

*Identification.* Litmus turns pink; paper may be destroyed with concentrated acid. Fingers and clothing are stained distinctly yellow on contact with the acid. (a) Copper alloy, such as a penny or a dime. Heat the unknown with (a); brown fumes ( $\text{NO}_2$ ) indicate nitric acid.

*Symptoms.* Burns, yellowish in color, appearing on the lips and mouth; severe pains in the throat and stomach, nausea and vomiting; thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, convulsions; collapse.

*Treatment.* Avoid emetics, stomach pump, or carbonates (avoid chalk, whiting, baking soda) if concentrated acid has been swallowed. Have the victim swallow plenty of water to help dilute the acid. Neutralize the acid with an alkali such as milk of magnesia, limewater, soapsuds, etc. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

*External Treatment.* Wash with abundance of water and apply a paste made with water and baking soda.

Acid, Oxalic ( $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ ) or acid of sugar (a name given oxalic acid because at one time it was manufactured from sugar or sawdust) is today produced by the action of carbon monoxide on sodium hydroxide. The pure colorless crystals it forms are so stable that they are used as an oxidation-reduction standard in analytical chemistry. Oxalic acid has a bitter taste, which makes it easy to detect. Industrially it is used to bleach textiles, straw hats, leather, and furniture, as well as in ink and rust eradicators and in metal polishes.

In medicine its chief use today is to react with, and remove, the permanganate wash from surgeon's gloves. Dentists use a 10% solution of oxalic acid to hasten the hardening of plaster of Paris impressions.

Persons have often accidentally swallowed oxalic acid thinking it was Epsom salts, because the two substances resemble each other in appearance. Owing to rapid absorption of oxalic acid, death is likely to occur within an hour, but it may be delayed for several hours. The lethal amount varies between 1 and 3 drams. Usually  $\frac{1}{2}$  to 1 ounce produces death. When the dose is too large, vomiting occurs, which offers relief, and possible recovery.

*Identification.* TEST 1. (a) Dil.  $\text{H}_2\text{SO}_4$ ; (b) aq. potassium permanga-

nate diluted to faint pink; (c) aq. manganous chloride. To 5 cc. of the unknown solution add 1 cc. of (a) + 10 cc. of (b) + a few drops of (c), the catalyst. If the solution becomes colorless when heated to just below boiling (tube uncomfortably hot to hold) for 5 minutes, oxalates are indicated. **Test 2.** (d) Aq.  $\text{CaCl}_2$ . Unknown solution + few drops (d). The white precipitate of calcium oxalate indicates oxalates.

**Symptoms.** Severe pains in the throat and stomach, nausea, and vomiting; intense thirst; rapid, weak pulse; slow, shallow breathing; twitching of the muscles; convulsions; collapse.

**Treatment.** Avoid baking soda, alkali carbonates, alkalies. Oxalic acid does not destroy stomach tissues as do nitric acid and other strong acids; instead it poisons the blood stream. Therefore, as soon as the patient has been given plenty of water to dilute the acid, and milk of magnesia to neutralize the acid, give an emetic of mustard in warm water to get the acid out of the stomach. Give stimulant of black coffee or whiskey if necessary. Use raw eggs and milk to protect the membranes of the esophagus and stomach. Keep the patient warm, quiet, and in a recumbent position.

**External Treatment.** Wash with an abundance of soap and water, and apply a paste made with water and baking soda for any redness or burns of the skin.

**Other Poisons.** Oxalates; same treatment as for Acid, Oxalic. See Potassium Binoxalate (salt of sorrel or salt of lemon).

**Acid, Phosphoric ( $\text{H}_3\text{PO}_4$ )** commonly refers to orthophosphoric acid, which is sold as a colorless, syrupy water solution containing 85%  $\text{H}_3\text{PO}_4$  in water. It is made by burning phosphorus and dissolving the oxide in hot water, or by adding sulfuric acid to either bone ash or to phosphate rock. Phosphoric acid is rapidly increasing in importance as an industrial acid; it is used also to produce phosphates, as a substitute for organic acids in foods and soft drinks, as a rust preventive, in engraving, in dental cements, to coagulate rubber, and in chemical analysis.

A weak solution is sometimes prescribed by physicians to relieve thirst from fever, and in stomach disorders.

Average dose of the solution is 15 minims, or 1 cc. Slightly less than 2 drams has caused death of an adult.

**Identification.** (a) Aq. silver nitrate; (b) dil.  $\text{HNO}_3$ . To aq. unknown add 1 cc. (a) + 1 cc. (b). The yellow precipitate of  $\text{Ag}_3\text{PO}_4$  indicates orthophosphates. Boil the original solution for 2 minutes



and repeat the test. The white precipitate of  $\text{Ag}_4\text{P}_2\text{O}_7$  or  $\text{AgPO}_3$  indicates phosphates.

*Symptoms.* Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, or convulsions; collapse.

*Treatment.* Avoid stomach tube, emetic, or carbonates, if the acid taken was in concentrated form. Give plenty of water to help dilute the acid. Neutralize the acid with limewater, or milk of magnesia. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

*External Treatment.* Wash with abundance of water, and apply a paste made with water and baking soda, or water and chalk.

Acid, Sulfuric ( $\text{H}_2\text{SO}_4$ ), vitriol, or oil of vitriol is a heavy, oily liquid, powerfully corrosive. It is manufactured by catalytically combining sulfur dioxide with oxygen to form sulfur trioxide; the latter with water forms sulfuric acid. Ordinary concentrated sulfuric acid contains about 98%  $\text{H}_2\text{SO}_4$  and does not fume, a still more concentrated variety known as fuming sulfuric acid, Nordhausen acid, or oleum and containing up to 80% free  $\text{SO}_3$  is used extensively in the dyeing industry. Both varieties have an enormous affinity for water and will char wood, paper, or the human body, though in the latter case charring may be only on the surface tissue if the acid has been immediately flushed off with water. A dangerous amount of heat is given off when water and concentrated sulfuric acid are mixed; always pour the acid into a very large amount of water, while stirring.

Sulfuric acid has been called "the yardstick of civilization" because, as perhaps our most important acid, it is used in nearly every chemical industry: textile, rubber, paper, petroleum, explosives, electroplating, etc.

ELIXIR OF VITRIOL is a mixture containing 19 to 21% sulfuric acid with alcohol, cinnamon, and ginger; the mixture finds a place in dentistry as protection against pyorrhea or decaying tissues. A 10% solution of sulfuric acid at one time was used to allay fever, in diarrhea, and in treating lead poisoning, etc.

Because of its tremendous corrosive action sulfuric acid is not usually given for homicidal purposes except to children. It is sometimes thrown on a person to disfigure him and may cause death from the severe burns inflicted on the skin. Most of the cases of poisoning

from this acid result from accidents. Death of an adult has been caused by 3.8 grams; and 20 drops may be fatal to a child.

**Identification.** Dilute sulfuric acid turns litmus pink and may stain clothing red. Concentrated sulfuric acid chars wood, paper, and sugar and burns brown holes in clothing. **Test 1.** (a) Make a dilute solution of the unknown (*Care! Add cautiously in order indicated, while stirring; keep the face away—much heat is evolved*) by adding 1 cc. of the unknown to 10 cc. of water; (b) aq. barium chloride; (c) dil.  $\text{HNO}_3$ . One cc. of the unknown solution + 1 cc. of (b) + 1 cc. of (c). A white precipitate of  $\text{BaSO}_4$  indicates sulfuric acid or sulfates.

**Symptoms.** Burns on the lips and mouth which are first whitish and later turn brown; severe pains in the throat and stomach, nausea and vomiting, intense thirst, difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; convulsions and collapse.

**Treatment.** Summon a physician. Avoid stomach tube, emetics, or carbonates (whiting, chalk, baking soda) if the acid taken was in concentrated form. Give plenty of water to help dilute the acid; then neutralize the acid with limewater, milk of magnesia, soapsuds, etc. Protect the mucous membranes of the esophagus and stomach by giving raw eggs and milk. Keep the patient warm and quiet.

**External Treatment.** Wash with abundance of water and apply a paste made with water and baking soda.

Aconite, friar's cowl, monkshood, mouse bane, or wolf's bane is obtained from the dried tuberous root of the *Aconitum napellus*, a source of alkaloids, and one of the deadliest drugs. It was used even by the ancients, who prohibited traffic in it under penalty of death. Aconitine ( $\text{C}_{34}\text{H}_{49}\text{O}_{11}\text{N}$ ), the active principle of the plant, is a bitter, white, crystalline powder.

At one time aconite was used internally to slow the pulse and to reduce fever; today its value is doubted. External use in neuralgia is also finding less favor, because of danger from absorption through the skin, and subsequent poisoning. If the aconite has been applied to a break in the skin tissue, poisoning from absorption is extremely likely. Also the investigator should distinguish between crystalline aconitine and amorphous aconitine; the crystalline variety is 10 to 15 times more poisonous than amorphous aconitine, and a mistaken dosage is possible. The majority of poisoning cases result from accidents. The symptoms come on rapidly; death from the pure alkaloid may occur suddenly; and death from the tincture usually takes place

in 3 or 4 hours. Death has resulted within 8 minutes. The fatal dose is uncertain, probably slightly over 1 mg.

*Identification.* (a) Syrupy phosphoric acid; (b) sodium molybdate solution. Unknown + a few drops of (a) + (b); heat over flame. A violet color indicates aconite. (c) Dil.  $H_2SO_4$ . Unknown + (c). Color changing from yellow to brown to violet indicates aconite.

*Symptoms.* An overdose causes salivation; a tingling sensation on the lips, mouth, and in the throat; nausea and vomiting; diarrhea; slow, weak pulse; collapse.

*Treatment.* Since the poison acts rapidly, the treatment must be prompt. Avoid emetics, since unless they can be given immediately they fail, and only cause the patient to exhaust himself. Give universal antidote, powdered charcoal. Give 4 grains of potassium permanganate in 240 cc. (8 oz.) of water. Keep the patient warm, quiet, and in a horizontal position with head low, apply cold to the head, heat to the body. Give a heart stimulant such as aromatic spirits of ammonia (1 teaspoonful in  $\frac{1}{2}$  glass of water) if necessary.

*Other Poisons.* Delphinine, larkspur, and veratrine call for the same treatment as for Aconite.

Alcohols are organic compounds containing the hydroxyl (OH) radical. They are of tremendous importance in chemical industry as solvents. The three alcohols most likely to be encountered are (1) *methyl* or *wood alcohol*, which causes blindness, followed by death; (2) *ethyl* or *grain alcohol*, which is a component of ordinary alcoholic beverages; and (3) *isopropyl alcohol*, which is commonly used as a rubbing alcohol. See below for treatments appropriate for each. Fusel oil is a mixture of amyl alcohols ( $C_5H_{11}OH$ ) produced in the fermentation of corn and other grains. They are bad smelling liquids which cause tears, coughing, headache, and dizziness.

Alcohol, Ethyl ( $C_2H_5OH$ ), ethanol, ethyl hydroxide, grain alcohol, rectified spirit, spirit of wine, or vinous alcohol is an inflammable, clear, colorless liquid having a characteristic pleasant odor and burning taste. It is produced by fermenting sugars as in molasses, or starches as in grains and potatoes. The fermenting materials are organic catalysts, called enzymes, which occur in yeast, a microorganism. Ethyl alcohol is also produced from the hydrocarbon gases acetylene and ethylene. Ethyl alcohol is used extensively as a solvent in perfumes, flavorings, extracts, and tinctures; in plastics, antiseptics,

gums, resins, shellacs, etc. It is a motor fuel in certain countries (e.g., India) where gasoline is scarce.

The common term "alcohol" generally means a water solution containing 95% ethyl alcohol, which is obtained by distillation. If special drying agents are used, the last 5% of water is removed and anhydrous or absolute alcohol is formed. *Denatured alcohol* is ethyl alcohol to which camphor, benzene, pyridine bases, or other substances are added to make it unfit as a beverage, while retaining its usefulness in other respects.

In beverages, ethyl alcohol content is classified on the proof-gallon, which is 50% water. According to this classification whiskey, rum, brandy, and gin are slightly under 100-proof (50% alcohol), wines are 20 to 40 proof (10 to 20% alcohol), and beers are 4 to 12 proof (2 to 6% alcohol).

Internally, ethyl alcohol is used as a stimulant (whiskey, brandy), a hypnotic, and a narcotic, and to settle the stomach. Externally it is used to sterilize the skin of patient and surgeon; and its cooling effect upon evaporation makes it useful as a lotion for bruises, inflammations, and headaches.

Death from this alcohol is usually the result of excessive drinking, although fatal results have occurred from even 1 pint of whiskey. Two and one-half ounces have proved fatal to a child.

*Identification.* TEST 1. (a) Aq. NaOH; (b) tincture of iodine. To 2 cc. of the unknown liquid add a few drops of (a); then drop by drop add (b) in excess (until the color is a permanent straw yellow). Characteristic iodoform odor or crystals (to obtain these, it may be necessary to heat the liquid for 1 minute and then cool) indicate ethyl alcohol, acetone, or some other organic substances; but iodoform is not given by methyl alcohol. TEST 2. (c) Copper wire. Heat the unknown liquid in a tube; plunge a red-hot copper spiral into the liquid. A sharp odor of formaldehyde indicates methyl alcohol. The sweeter odor of acetaldehyde indicates ethyl alcohol present in the original unknown.

*Symptoms.* Effects vary in individuals: some become quarrelsome, others sentimental, still others fall asleep and have no stage of excitement at all. When large amounts are taken, nausea and vomiting occur, and the patient enters a depression stage.

*Treatment.* The stomach should be washed out with an emetic. Give 4 gm. of sodium bicarbonate in water to counteract acidosis.

Apply cold applications to the head; give stimulants of hot coffee or tea; keep the patient warm and quiet.

Alcohol, Isopropyl  $[(CH_3)_2CHOH]$ , dimethylcarbinol, isopropanol, or secondary propyl alcohol is a colorless liquid with an acetone-like odor. The alcohol is manufactured as an oxidation product of petroleum, and appeared in 1940 as a substitute for denatured, rubbing alcohol, the latter being an important military chemical.

*Identification.* Isopropyl alcohol has an odor somewhat resembling acetone. (a) Mercuric sulfate solution (to make, stir 2 gm. of yellow mercuric oxide with 16 cc. of water; then add 8 cc. of conc.  $H_2SO_4$  and continue stirring, finally add 16 cc. more water and stir until completely dissolved). Mix 1 cc. of the unknown liquid with 5 cc. of (a); heat very gently (in a steam bath) for 5 minutes. A precipitate shows that the original was isopropyl alcohol, acetone, or other ketones.

*Symptoms.* Not a great deal is known about the poisonous characteristics of isopropyl alcohol, but its characteristically unpleasant odor serves to warn against use in beverages. It is more likely to cause nausea and vomiting than to poison dangerously.

*Treatment.* Same as for Alcohol, Ethyl.

Alcohol, Methyl ( $CH_3OH$ ), Hasting's naphtha, methanol, pyro alcohol, pyroligneous spirit, wood alcohol, or wood naphtha is a clear, colorless liquid, possessing a winelike characteristic odor, and a burning taste. Previous to 1924 it was obtained by the distillation of wood; hence the name wood alcohol. Today it is manufactured catalytically by adding hydrogen to water gas or from hydrogen and carbon monoxide. Industrially it is important as a solvent for shellacs and resins, as an antifreeze for automobiles, as a motor fuel, and in the manufacture of many organic chemicals.

Methyl alcohol is toxic in small doses, even if inhaled; and in the concentrated form affects the optic nerve, causing blindness. The fatal dose varies between 1 and 2 ounces. It has been stated that 4 ounces of wood alcohol drunk by each of ten persons would produce pain in the abdomen in all within 3 hours; four would die, two of these would be blind before death, six would recover, but of these six, two would be permanently blind. A concentration of 200 ppm of vapor is the maximum allowable concentration for an 8-hour working day recommended by the American Conference of Governmental Industrial Hygienists.

*Identification.* See tests under Alcohol, Ethyl.

*Symptoms.* The beginning symptoms are similar to those caused by grain alcohol: exhilaration and excitement, followed by nausea and vomiting, dizziness, headache, dilated pupils and delirium. Persevering coma and death may follow within hours or a few days. The victim may recover from the acute symptoms but blindness may result from the destruction of the optic nerve.

*Treatment.* The stomach should be washed out with 240 cc. of a solution of sodium bicarbonate (about 1%), and with an emetic and large quantities of water. Keep the patient warm and quiet. Keep light away from the eyes.

*Aldrin.* See Chlordane.

*Ammonia.* See Ammonium Hydroxide.

**Ammonium Hydroxide** ( $\text{NH}_4\text{OH}$ ), ammonia water, aqua ammonia, or spirits of hartshorn is formed when ammonia gas,  $\text{NH}_3$ , is dissolved in water; the concentrated commercial solution contains 28 to 29%  $\text{NH}_3$ . It has a pungent, suffocating odor, an acrid taste, and is clear and colorless. Ammonium hydroxide is used in cleaning, in removing stains and dirt, in bleaching calico, in extracting plant dyes, in manufacturing ammonium compounds, and for a wide variety of uses around the home. Liquid ammonia is used as a refrigerant liquid in some artificial skating rinks and commercial refrigerating units. Household ammonia may be clear or cloudy; in the latter case ammonium carbonate has been added to improve the product.

**HARTSHORN SALT**, a smelling salt, is a mixture of ammonium carbonate and carbamate.

**AMMONIA WATER** U.S.P. XV, a 10% aqueous solution, is used by some physicians internally as aromatic spirits to prevent fainting. The external use of sniffing the vapor to revive persons who have fainted is well known; it is also a convenient wash to neutralize the acid in bee and insect stings.

**AMMONIUM HYDROXIDE** is a powerfully corrosive poison, and inhaling much fumes gives rise to bronchopneumonia. Ammonium hydroxide has often been taken accidentally, and in some cases as a means of homicide or suicide.

**AMMONIA FUMES** in concentrations of 0.5 to 1.0% by volume are lethal to man in a few minutes. A teaspoonful of concentrated am-

monium hydroxide has caused death; on the other hand recovery has followed the taking of a fluid ounce.

*Identification.* Turns litmus blue. Characteristic odor in breath and vomitus. (a) Conc. HCl. Bring an open bottle of (a) near the unknown. White fumes of  $\text{NH}_4\text{Cl}$  indicate ammonium hydroxide.

*Symptoms.* If strong ammonia fumes are inhaled, they cause the larynx to swell; this may cause asphyxia. When the solution is swallowed, extensive destruction is done to the mucous membranes of the esophagus. Large quantities cause convulsions and collapse in addition to the always present nausea and vomiting, pain in the throat and stomach, and a cold, clammy skin.

*Treatment.* Avoid emetics or stomach tube. Neutralize the alkali at once with an abundance of vinegar, 15 to 30 cc. ( $\frac{1}{2}$  to 1 oz.) in a large volume of water, diluted lemon or orange juice, or other weak acid juices. Follow with raw eggs, cream, or olive oil to protect the membranes. Administer oxygen or artificial respiration if necessary. Keep the patient warm and quiet. Do not leave him alone for 24 hours.

*External Treatment.* Wash thoroughly with water, then with lemon juice, vinegar, and again with water. If the ammonium hydroxide has got into the eyes, wash with a 5% solution of boric acid.

*Antabuse.* See Disulfiram.

*Antimony (Sb), stibium, or regulus of antimony* is a silvery white, lustrous, hard, brittle metal which occurs naturally as the sulfide,  $\text{Sb}_2\text{S}_3$ , called stibnite. As a metal it is tasteless, odorless, and nontoxic. Heated, it volatilizes in air, forming antimony oxides. The compounds of antimony are toxic. Antimony trichloride, a liquid, and antimony potassium tartrate (tartar emetic) are the two compounds usually encountered in poisoning cases. Antimony and its compounds are used in medicine, in alloys, in fireworks, as a bronzing liquid, to blacken iron, etc. Salts of this metal have been responsible for cases of homicide, suicide, and accident. A fatal dose may cause death in from a few hours to a few days. Since the compounds of antimony produce vomiting, the exact fatal dose is uncertain. One and one-half grains has caused death of an adult, and  $\frac{3}{4}$  grain has proved fatal to a child.

*Identification.* See arsenic tests for the necessity and the method of removing organic matter. (See page 17, spot tests.) Orange sulfide,  $\text{Sb}_2\text{S}_3$ , is characteristic.

*Symptoms.* The victim has a metallic taste, pains in the epigastric, shock symptoms, vomiting of blood-stained material; spasms of the fingers, arms, and legs; collapse.

*Treatment.* Give about 20 grains of tannic acid at once in a cupful of warm water, and repeat in 5-grain doses every 30 minutes. If this is not available give strong tea. Empty the stomach with emetic, give large quantities of warm water followed by raw eggs or milk. Keep the victim warm and quiet.

Antipyrine ( $C_{11}H_{12}ON_2$ ), analgesine, anodynine, dimethyl-oxyquinizine, oxydimethyl-quinizine, parodyne, phenazone, phenylone, 1-phenyl-2, 3-dimethylpyrazolon, pyrazoline, or sedatine is a colorless, odorless powder or tabular crystals. Its uses, symptoms, and treatment are similar to those for Acetanilid.

*Identification.* Antipyrine may be in urine, which should be made alkaline, then antipyrine extracted with chloroform. TEST 1. (a) Aq. potassium nitrite; (b) dil.  $H_2SO_4$ . Unknown in water + 1 cc. of (a) + 1 cc. of (b). Green crystals indicate antipyrine. (Nitroso test.) Fading blue-violet indicates aminopyrine. TEST 2. (c) Aq. 10%  $FeCl_3$ . Unknown solution + 1 drop of (c). Deep red indicates antipyrine.

*Symptoms and Treatment.* Same as for Acetanilid.

ANTU ( $C_{10}H_7NH \cdot CS \cdot NH_2$ ), 1-(1-naphthyl)-2-thiourea, alpha-naphthylthiourea, is a rodenticide. This substance is a good rat killer for the brown or Norway rat but is not very useful for other species of rats; it shows a marked species differentiation. It is a crystalline solid, with a bitter taste, melting at  $198^\circ C$ , and is practically insoluble in water.

*Symptoms.* In animals there is a sharp drop in temperature in 30 to 60 minutes and pulmonary edema which may be the cause of death. One gram is considered the fatal dose for human beings.

*Treatment.* Induce vomiting by sticking a finger in the throat or by getting the victim to drink warm water or an emetic such as sodium chloride solution. Keep the victim warm and quiet.

Apomorphine ( $C_{17}H_{17}O_2N$ ) is an artificial alkaloid made from morphine by removing 2 molecules of water from the morphine structure. Apomorphine is a white, crystalline substance that oxidizes rapidly, the aqueous solution turning green on exposure to air and light.

It is used medically as a heart depressant, emetic, hypnotic, and expectorant; and as a sedative in acute alcoholism. The compound



apomorphine hydrochloride is used in injections; if the solution is not fresh, poisoning may result.

The prescribed dose of apomorphine administered subcutaneously as an emetic is  $\frac{1}{60}$  grain, or 0.001 gm. The fatal amount is very indefinite.

*Identification.* (a) 3%  $H_2O_2$ ; (b) chloroform; (c) crystals potassium dichromate. To the unknown residue, add 1 cc. of (a) + 2 cc. of (b) containing a crystal of (c). Blue, violet, and finally dark blue solution when shaken indicates antipyrine, apomorphine, or strychnine (Heich's test).

*Symptoms.* When given hypodermically apomorphine causes, in a few minutes, intense nausea and vomiting, pallor, flow of tears, exhaustion, and collapse.

*Treatment.* Keep the patient quiet, recumbent, and warm by applying external heat. Give aromatic spirits of ammonia (1 teaspoonful in  $\frac{1}{2}$  glass of water) or ammonia by inhalation. Treat for morphine poisoning after the emetic effects are gone. Administer artificial respiration if necessary.

Arnica, leopard's bane, mountain alkanet, mountain tobacco, or wolf's bane is obtained from the dried flower heads of the *Arnica montana* L. Compositae, a plant growing throughout the northern hemisphere. Arnica is commonly used externally as a counterirritant for sore muscles, bruises, sprains, and strains. The quantity that is lethal varies; but arnica can produce fatal results in a short time.

*Identification.* Characteristic odor.

*Symptoms.* Nausea and vomiting, slow, weak pulse; subnormal temperature, pallor.

*Treatment.* Keep the patient warm and quiet, give an emetic to produce vomiting; give medicinal charcoal; follow with raw eggs, milk or other demulcent drinks, oatmeal, or cereal gruels.

*External Treatment.* Wash thoroughly with soap and water.

Arsenic (As) or arsenium is a brittle, steel-gray, lustrous, crystalline solid. Its compounds are poisonous, Paris green being an important copper salt of arsenic.

Arsenic and its compounds are used for hardening metals, in alloys, rat poisons, flypaper, tree and garden sprays, paper glazes, dyes, pigments, wallpapers, etc.

Arsenic compounds are used by poisoners more than any other class

of poisons because of their odorless and almost tasteless qualities. In several cases they have been introduced into the vagina, rectum, or urethra. They have also been used to induce abortion. The poisoner may either give a large dose or administer several smaller doses to simulate a natural illness. Cases of suicidal and accidental poisoning frequently occur as a result of ingesting rat poison or Paris green. Poisoning can also occur from eating vegetables and fruit from areas where a spray was used. The intensity of the toxemia depends on the amount of the arsenic ingested and the speed with which it enters the blood. When arsenic is administered in solution, the absorption is faster than when given in a solid form. The acid found in the stomach will act as a solvent. The lethal dose of most arsenic compounds varies from 0.1 to 0.5 gm.; yet woodcutters have accustomed themselves to such doses, which enable them to carry heavy loads with ease.

*Identification.* Many tests for arsenic and antimony do not work unless organic matter is destroyed. The Reinsch test (Test 2) works with some but not all organic arsenicals. Try the spot tests, page 17; if these give no positive tests for arsenic (or antimony), assume that there may be organic matter present, and proceed to destroy organic matter as follows (Strzyzowski method): (a) Aq. saturated magnesium nitrate made alkaline with magnesium oxide. Gently heat 20 gm. of unknown with 10 cc. of (a) in a porcelain casserole. The mass softens and chars. Then heat more strongly; this gives a gray ash of magnesium pyroarsenate ( $Mg_2As_2O_7$ ) and magnesium pyroantimonate ( $Mg_2Sb_2O_7$ ). Soak the ash in 25 cc. of water; filter and use the clear solution for the following tests. TEST 1. See spot tests, page 17. The yellow sulfide forms only slowly. TEST 2. (Reinsch test. All reagents must be arsenic-free; confirm this by running a blank, in the absence of unknown.) (b) Arsenic-free dil. HCl; (c) arsenic-free burnished copper foil. Acidify 10 cc. of the unknown solution with (b) until it is barely pink to litmus. Now add (c), and boil for 30 minutes, adding water from time to time to replace that lost by evaporation (the acid must not become too concentrated). If the foil turns black or brown, it indicates arsenic, antimony, silver, mercury, or bismuth. Wash the foil under running water, then place it in a small, closed tube, and heat gently. If the deposit vaporizes and deposits further up the tube (sublimes), it indicates arsenic; the other metals do not sublime. TEST 3. (Gutzeit modification of the Marsh-Berzelius test; it will not work with many organic arsenicals

unless treated according to the Strzyzowski method described above.) (d) Arsenic-free mossy zinc; (e) arsenic-free dil. HCl; (f) aq. 5% mercuric bromide. Place a piece of (d) in a tube with the unknown; add 5 cc. of (e). When bubbles are evolved, hold filter paper dipped in (f) to the mouth of the tube. The paper turns yellow-red, it indicates arsenic, hydrogen sulfide, or other reducing agent.

*Symptoms.* The symptoms do not usually appear until about  $\frac{1}{2}$  to 1 hour after the poison is taken. The victim will have a burning sensation in the throat, pain in the stomach, pallor, nausea and vomiting, abdominal cramps, and thirst; cold, moist skin; slow, shallow breathing; rapid, thready pulse; coma, convulsions, collapse.

*Treatment.* (Arsenic compounds.) Empty the stomach at once with an emetic (mustard or 30 to 60 grains of zinc sulfate in water). Also give Epsom salts in water (1 tablespoonful) followed by 30 grains of potassium bromide in water. Give plenty of water to replace fluids lost from the alimentary canal. Protect the membranes with raw eggs and milk. The official U.S.P. antidote is hydrated oxide of iron and magnesia.

*Other Poisons.* The treatment given above can be used also for victims of cobalt salts, as well as the arsenic compounds in ant pastes, arsenites, arsenous acid (white arsenic), Donovan's solution, flypaper, Fowler's solution, Paris green, rat poison, "Rough on Rats," Scheele's green, and other arsenic insecticides.

Aspirin ( $\text{CH}_3\text{COO} \cdot \text{C}_6\text{H}_4 \cdot \text{COOH}$ ), acetylsalicylic acid, is a crystalline solid that melts at  $135^\circ \text{C}$ . It is odorless but may hydrolyze to give a slight odor of acetic acid (vinegar). It is slightly soluble in water, 1 gm. dissolving in 300 cc. of water at room temperature. Aspirin is very widely used as an analgesic and antipyretic. It is a component of nearly all analgesic-type tablets. Cases of aspirin poisoning are known and a number of deaths have occurred. Those requiring particular note are poisoning and death occurring in children from the ingestion of flavored and sweetened aspirin.

The usual dose ranges from 0.3 to 1 gm. Ten grams may cause death and 30 to 40 gm. are usually fatal.

*Identification.* **TEST 1.** Boil 0.2 to 0.4 gm. of the sample with 2 cc. of Millon's reagent for 30 seconds. Aspirin gives a cherry-red color. **TEST 2.** Add a few drops of a solution of 1 gm. of ammonium molybdate in 100 cc. of sulfuric acid. Aspirin gives a blue color changing to violet.

**Symptoms.** The symptoms of aspirin poisoning are those characteristic of poisoning by salicylates like methyl salicylate or oil of wintergreen and salicylic acid: rapid breathing, nausea, vomiting, thirst, headache, irritability, delirium and hallucinations, convulsions, deep coma, and death attributable to respiratory failure.

**Treatment.** Give universal antidote and then wash the stomach with 240 cc. (8 oz.) of a potassium permanganate solution containing 4 grains  $\text{KMnO}_4$ ; give additional washing with 500 cc. of 5% sodium bicarbonate solution.

**Atropine** ( $\text{C}_{11}\text{H}_{23}\text{O}_3\text{N}$ ), atropia, or atropina is an alkaloid obtained from the roots of the *Atropa belladonna* L. and some other Solanaceae plants. Intensely poisonous, it forms white odorless crystals which have a bitter acid taste.

Atropine or its salts are used to control spasms and to stimulate respiration. It is used internally for a large variety of purposes by the physician; but its violently poisonous nature makes it dangerous in the hands of anyone but an expert. Applied on the skin, usually as the sulfate, oleate, or other salt of atropine, it relieves pain by paralyzing sensory nerve endings on the skin, and is often used for this purpose in the form of a belladonna plaster.

The prescribed dose is  $\frac{1}{150}$  grain, or 0.0004 gm. Dangerous symptoms and death have resulted from 0.1 gm. of atropine for adults, and 0.01 gm. for children.

**Identification.** **TEST 1.** (a) Fuming  $\text{HNO}_3$ ; (b) alcoholic potassium hydroxide. Moisten residue with (a) and evaporate to dryness in a tube in a stream of steam from a kettle. Cool. Add a few drops of (b). Violet, turning red and finally turning colorless, indicates the atropine group. (Vitali's test.) **TEST 2.** (a) Hydrobromic acid saturated with bromine; if the unknown + (a) yields yellow precipitate, amorphous and turning leaflike, it indicates atropine. Brown globules possibly turning leaflike indicate scopolamine.

**Symptoms.** Excessive thirst and dryness of the mouth and throat, difficulty in swallowing, dry flushed skin, rapid pulse, rapid respirations which become slow and shallow, dilated pupils, talkativeness, and confusion which may become quarrelsome, convulsions, stupor, coma, collapse.

**Treatment.** Wash out the stomach with 5% tannic acid solution, or give an emetic of mustard water; apply ice to the head. Apply

artificial respiration if necessary. Use black coffee as a stimulant. Keep warm and quiet.

*Other Poisons.* Belladonna, daturine, suboisine, hyoscyamine, scopolamine, hyoscine, solanine, and stramonium call for the same treatment as Atropine.

Barbital  $\{(\text{C}_2\text{H}_5)_2\text{C}_3\text{H}_2\text{O}_3\text{N}_2\}$ , barbitol, barbitone, diethylbarbituric acid, diethyl malonylurea, or veronal is an odorless, white crystalline powder with a faintly bitter taste.

It is prescribed by some physicians for internal use to quiet convulsions, and during the intervals between epileptic fits; for seasickness, for simple insomnia, as a sedative to quiet nerves and lessen hysteria, to lower blood pressure, and for relief from neuralgia pains and headache. Derivatives of barbituric acid are known as barbiturates.

SOLUBLE BARBITAL is a water-soluble sodium salt, particularly suited for injections. Doses, effects, and treatment are similar to those for ordinary barbital.

An average dose (5 grains, or 0.3 gm. causes the patient to fall into a deep sleep, which lasts from 4 to 8 hours. On awakening, the patient often has dizziness and headache. Barbital is reasonably safe in small doses. Death has resulted from 1 gm., on the other hand recovery has followed after more than 8 gm. were taken.

*Identification.* TEST 1. (a) Aq. sodium bicarbonate. Boil the unknown with (a). Ammonia liberated indicates barbital. TEST 2. (b) Glacial acetic acid; (c) aq. mercuric chloride; (d) dil. NaOH. Dissolve the unknown in (b). Then a few drops of (c), then (d). A white precipitate indicates barbiturates.

*Symptoms.* With an overdose, the victim is mentally confused and drowsy; coma follows. Pulse rapid, weak, irregular, skin moist; blood pressure low; cyanosis; the pupils usually constrict, but may be dilated; collapse follows.

*Treatment.* If the patient is conscious, give an emetic of mustard and water; use strong black coffee as a stimulant; keep the patient awake by slapping with a wet towel across the neck, back, and face; keep him warm with blankets and external heat until the physician arrives. If necessary, administer oxygen with 5% carbon dioxide to relieve cyanosis.

*Other Poisons.* Allonal, amytal, dial, ipral, neonal, pentobarbital (nembutal), phenobarbital, and other barbiturate derivatives call for the same treatment as barbital.

Barium (Ba) is a silvery metal belonging to the alkaline earths. As a free metal it has no importance. Many compounds are derived from barium, most of which are white in color, yellowish if impure. All water- and acid-soluble compounds of barium are poisonous. The compounds are widely used in industry for printing fabrics; in rat poisons, ceramics, paints, enamels, pigments, explosives, and matches; in the manufacture of optical glasses and paper; in boiler compounds for softening water, etc.

The action of the poison is rapid and may kill within 1 hour, but in some cases the victim lives a few days. The fatal dose is variable; approximately 1 gm. has caused the death of an adult, although in some cases recovery has followed after much larger doses had been taken. Death usually results from paralysis of respiration.

Note that in obtaining X-ray photographs of the alimentary canal, barium sulfate carefully freed of all soluble barium salts is swallowed; but that barium sulfide and barium sulfite are very poisonous.

**Identification.** TEST 1. Flame test, page 17. A green flame indicates barium. TEST 2. (a) Aq. ammonium carbonate. (b) dil. acetic acid; (c) aq. potassium dichromate. Aq. unknown + 1 cc. of (a). A white precipitate may be barium carbonate. Dissolve the precipitate in (b); add (c). The yellow precipitate of barium chromate indicates barium.

**Symptoms.** Nausea and vomiting, abdominal cramps, diarrhea, salivation, paralysis of the arms and legs, pallor.

**Treatment.** Give Epsom salts (1 tablespoonful) or sodium sulfate, 15 to 30 gm. ( $\frac{1}{2}$  to 1 oz.), followed by an emetic, repeat; follow with milk and water. Keep the patient warm and quiet.

Belladonna, banewort, deadly nightshade, death's herb, dwale, or poison black cherry is a mixture of alkaloids obtained from the dried leaves and tops of the *Atropa belladonna* L. and some other Solanaceae plants. The leaves and root contain 0.3 to 0.4% total alkaloids, chiefly atropine, hyoscyamine, and scopolamine, and are used as sources of the alkaloids. The normal dose is  $\frac{1}{2}$  to 2 grains (30–120 mg.); the maximum dose is 3 grains (200 mg.).

**Identification.** Same as Atropine.

**Symptoms.** Nausea and vomiting, abdominal cramps, diarrhea, salivation, paralysis of the arms and legs, pallor, weakness, and general paralysis.

**Treatment.** Wash out the stomach with 5% tannic acid solution; give emetics; apply ice to the head; apply artificial respiration if neces-

sary. Use black coffee as a stimulant. Keep the patient warm and quiet.

**Benzene Hexachloride** ( $C_6H_6Cl_6$ ), BHC, 1,2,3,4,5,6-hexachloro-cyclohexane is an insecticide. The commercial product contains a mixture of various isomers. It is used in a wide variety of formulations including solutions, emulsions, wettable powders, dusts, and poison baits. Lindane, which is essentially the pure gamma isomer, is used in the form of powders, wafers, pellets, or crystals in vaporizers.

The ingestion of from  $\frac{2}{3}$  to 1 oz. (20 to 30 gm.) will cause serious symptoms but will probably not be fatal; however, only 3.5 gm. of lindane is a toxic dose.

*Symptoms.* The poison can be ingested, absorbed through the skin (particularly from solutions in organic solvents) and inhaled from vaporizers. Vomiting and diarrhea are generally the first symptoms and occur in from 1 to 6 hours. These lead to convulsions, difficult breathing, cyanosis, and circulatory failure.

*Treatment.* Give universal antidotes and follow by washing the stomach. Give about 1 oz. of sodium sulfate in water as a cathartic and force the acceptance of fluids. Hot tea or coffee may be used. If the poisoning results from inhalation, the victim must be taken out to fresh air.

**Beryllium.** See Chapter 5.

**Bismuth (Bi)** is hard, brittle, and grayish-white to reddish in color. Its compounds are usually white or light yellow.

The free metal is used in low-melting alloys such as those for electrical fuses, automatic sprinkler heads, fusible boiler plugs, and dental alloys. About 90% of all bismuth consumption is for medicines, principally for intestinal and stomach remedies. Bismuth carbonate and nitrate are used in X-ray examination of the esophagus and stomach. Most medicinals contain the bismuthyl ( $BiO$ ) radical, such as  $BiONO_3$  (bismuthyl nitrate, or bismuth subnitrate); this includes the common medicines bismuthyl subcarbonate, subgallate, and subsalicylate.

Poisoning is usually due to bismuth dressings being left on too long and is rarely fatal. Under certain conditions bismuth salts may become poisonous, but under ordinary circumstances even larger amounts are harmless.

*Identification.* See page 17, spot tests.

*Symptoms.* The symptoms, resembling those of mercury poisoning, appear slowly. Nausea and vomiting; excessive flow of saliva; a blue line at the junction of the teeth and gums; swelling of the gums, tongue, and throat.

*Treatment.* The symptoms usually disappear after the dressings are removed. Even in this case a physician should be summoned.

**Borates.** See Acid, Boric.

Bromides like sodium bromide ( $\text{NaBr}$ ), potassium bromide ( $\text{KBr}$ ), and ammonium bromide ( $\text{NH}_4\text{Br}$ ) are water-soluble salts that are used as drugs to allay emotional stress, induce sleep, and for the control of epilepsy. Occasionally poisoning results from too great a dose or the ingestion of too much of the drug. The usual dose is 0.5 to 1 gm. A blood level above 50 milligrams per 100 cc. of blood is indicative of a toxic level.

*Identification.* Bromides may be detected in the urine. (a) Fuming nitric acid; (b) chloroform. Add a few drops of fuming nitric acid and 5 cc. of chloroform to 10 cc. of urine. Mix carefully and allow to stand 3 minutes. A yellow color in the chloroform layer indicates the presence of bromides.

*Symptoms.* Mental confusion is a principal symptom of bromide poisoning. The ingestion of large amounts produces nausea, vomiting, pain in the stomach, delirium, coma, and paralysis.

*Treatment.* If recently swallowed give an emetic and gastric wash. Afterwards give 1 oz. of sodium sulfate in water and force fluids.

Cadmium ( $\text{Cd}$ ) is a metal that is used for the plating of other metals to protect them against corrosion and for the manufacture of alloys. Its salts and compounds are used as in photography, for plating, and as pigments. Many cases of food poisoning attributable to the ingestion of food contaminated by the dissolving of cadmium plating from containers by food acids are reported yearly. As little as 10 milligrams will cause toxic symptoms. It is also an industrial poison (see page 161).

*Identification.* Spot tests for cadmium have been listed on page 17.

*Symptoms.* The principal symptoms caused by the ingestion of cadmium are nausea, vomiting, diarrhea, headache, salivation, stomach pains, and muscular pains.

*Treatment.* Give milk or beaten eggs as a demulcent. Give 1 oz.



of sodium sulfate in 240 cc. (8 oz.) of water as a cathartic. BAL can be used.

Caffeine ( $C_8H_{10}O_2N_4 \cdot H_2O$ ), guaranine, methyltheobromine, theine, or trimethylxanthine is an alkaloid obtained from coffee, Paraguay tea, guarana, and kola nuts. It forms a white powder or long silky crystals, which are odorless and have a bitter taste. Usually tea contains from 1.5-3.5% caffeine.

Caffeine is used chiefly as a stimulant, for which purpose it is ideal because it increases the activity of almost every organ of the body. In small doses it stimulates muscular contraction and lessens fatigue; larger doses have an exactly opposite effect.

Poisoning from caffeine is rare. If it occurs it is usually acute poisoning, resulting from the "coffee habit." Normal dose is 1 to 4 grains (60 to 250 mg.).

*Identification.* TEST 1. (a) Mayer's reagent. Neutral caffeine + Mayer's reagent gives no precipitate; other alkaloids do. TEST 2. (a)  $HNO_3$ ; (b) dilute  $NH_4OH$ . Unknown + (a) + (b). Violet to red indicates caffeine, theobromine, theophylline.

*Symptoms.* Restlessness, headache, excitement, mental confusion, pain over the heart, palpitation of the heart, sleeplessness, high blood pressure, and rapid pulse.

*Treatment.* The symptoms usually disappear after the patient has stopped using coffee. A physician should be consulted in any event.

Calcium Oxide ( $CaO$ ), burnt lime, calx, quicklime, or unslaked lime is sold as dry, white or grayish-white lumps or powder containing about 95%  $CaO$ , the remainder being water. Care must be exercised if water is added to the lumps, this should be done only in an open vessel, with great caution, since steam is violently given off. Water "slakes" the lime to form calcium hydroxide [ $Ca(OH)_2$ ], slaked lime, lime slurry, or limewater. The water solution may be clear or cloudy-white, with a saline taste. Lime, slaked or unslaked, is used in plasters, cements, mortars, whitewash, dehairing of hides, as insecticide spray, and in medicine externally or mixed with oil to form a liniment.

*Identification.* TEST 1. Flame test, page 17 Orange flame indicates calcium. TEST 2. (a) Aq. ammonium carbonate, (b) dil. acetic acid; (c) aq. ammonium oxalate. One cc. of unknown aq. solution + 1 cc. (a). White precipitate may be calcium carbonate. Dissolve in (b) and add 1 cc. (c). White precipitate of calcium oxalate indicates calcium.

**Symptoms.** Pain in the throat and stomach; nausea and vomiting; thirst; subnormal temperature; cold, clammy skin; rapid, weak pulse.

**Treatment.** Summon a physician regardless of whether injury is internal or external. Give dilute acids such as lemon or orange juice, vinegar, etc.; empty the stomach with emetics; give raw eggs and milk. Keep the victim warm and quiet.

**External Treatment.** Wash thoroughly with water, then with lemon juice or vinegar, and again with water.

Camphor ( $C_{10}H_{16}O$ ), gum camphor, or Formosa, Japan, or laurel camphor is obtained from an evergreen tree, the *Cinnamomum camphora*, which grows in the Far East. Much of the camphor available in the United States today is synthetic bornyl chloride ( $C_{10}H_{17}Cl$ ), also known as chlorocamphane, terpene hydrochloride, or turpentine camphor, a substance that resembles camphor. It is manufactured from turpentine, and in 1932 it broke the Japanese camphor monopoly.

Industrially camphor is used for manufacturing celluloid, explosives, and fireworks; as an insect repellent; in lacquers; and for embalming.

Camphor is used internally as a heart and respiratory stimulant; as a sedative for nervousness and in hysteria; in cases of shock; and for colds, hiccup, and severe diarrhea. Externally it is used for toothache, neuralgia, and similar pains, boils, etc. Vapors are inhaled for head colds.

The products most likely to be swallowed are camphor liniment; camphorated oil; camphoric acid or soap liniment. The average dose of camphor if taken orally or by injection is 3 grains or 0.2 gm. One gram or less may cause toxic symptoms in adults, in children this amount is fatal.

**Identification.** Water precipitates camphor, with characteristic odor, from non-aqueous solutions.

**Symptoms.** A hot, bitter taste; burning pain in the throat and stomach; nausea, colic and vomiting; headache, dizziness, poor vision; delirium; convulsions, weak pulse; pallor; cold, moist skin; collapse. The symptoms usually disappear after use of the drug is stopped.

**Treatment.** Empty the stomach with emetics (zinc sulfate 20 grains, or mustard in water); give stimulants, such as black coffee; give ether to be inhaled and artificial respiration if necessary; keep the patient quiet and warm.

**External Treatment.** Wash thoroughly with soap and water.

Cantharides, Spanish fly, blistering fly, or blistering beetle from the dried insect, *Cantharis vesicatoria*, contains a powerfully poisonous principle known as cantharidin.

Applied locally cantharides causes redness of the skin. When taken internally it is an irritant.

It is used externally as a vesicant in pleurisy, synovitis, neuritis, subacute rheumatism, etc.; also in medicinal hair tonic. Its use for incontinence of urine has ceased because of the danger of nephritis.

The fatal dose varies from 1.5 to 3.0 gm. Cantharides is highly toxic, and poisoning has resulted from its use. It has also been used with criminal intent.

**Symptoms.** Burning sensation in the mouth and throat, followed by swelling and blistering, thirst, nausea, and vomiting; abdominal pain; salivation; bloody diarrhea; slow, feeble pulse, sometimes chills; delirium followed by collapse.

**Treatment.** Empty the stomach several times with an emetic of mustard and water; follow with the whites of several eggs and milk. (Give large volumes of water between emetics.) Keep the patient warm and quiet.

**Carbolic Acid.** See Phenol.

Carbon Dioxide ( $\text{CO}_2$ ), carbonic acid gas, or carbonic anhydride is a colorless, odorless, noncombustible gas. It is used as an antiseptic in brewing; in carbonated beverages; and is compressed and stored as a liquid in steel cylinders for use in fire extinguishers, and for medical purposes (see below).

If carbon dioxide is cooled sufficiently, carbon dioxide snow, or Dry Ice, is formed; this is manufactured industrially to chill and preserve foods. Because it is heavier than air it may collect in low places, such as the floors of mines, brewery vats, etc., and is a source of danger there. Several persons were asphyxiated in Brooklyn in 1936 while working in the hold of a ship when solid carbon dioxide was being used as a refrigerant and similar instances of death resulting from entry into spaces where carbon dioxide has accumulated occur yearly. One should never enter a space, pit, hold, tank, or the like, if high concentrations of carbon dioxide are suspected unless a self-contained, oxygen-supplying or supplied-air respirator is available. An additional dead person will never save the first victim.

Dry Ice causes severe blisters on the skin; this dangerous property

is utilized in removing growths and birthmarks from the skin with a "snow pencil," a small rod of Dry Ice.

For medicinal use, the pure gas is never breathed, for it will cause death from asphyxia in a few minutes. Instead, 5% to 7% pure carbon dioxide is mixed with 95% and 93% oxygen; and this mixture is breathed to stimulate respiration.

A concentration of 3.5% or 35,000 parts per million is injurious if breathed for an hour. The maximum allowable concentration for an 8-hour working day adopted by the American Conference of Governmental Industrial Hygienists is 0.5% or 5000 ppm.

*Identification.* If a tank of the suspected gas is at hand, run some into a glass. A burning match thrust into the glass will be extinguished. Bubble the gas through limewater; a white precipitate ( $\text{CaCO}_3$ ) first forming, then redissolving, to form soluble  $\text{Ca}(\text{HCO}_3)_2$ , indicates carbon dioxide.

*Symptoms.* Labored breathing, unconsciousness, and failure of respiration and circulation.

*Treatment.* Oxygen, fresh air, external heat applied to body and extremities, artificial respiration if necessary. If the victim is conscious, give a stimulant. Keep warm and quiet. Remember that carbon dioxide is a serious poison.

**Carbon Disulfide.** See page 161.

**Carbon Monoxide ( $\text{CO}$ )** (see also Chapter 5) present in automobile exhaust gas, coal gas, furnace gases, and illuminating gas, is formed by the combustion of carbon compounds. Carbon monoxide is a component of water gas and of producer gas, which are formed by passing water or air, respectively, over heated coke (carbon). Both gases are important industrial fuels, and are the starting materials for synthetic methyl alcohol, ammonia, gasoline, etc.

Carbon monoxide is the most widespread human poison on record. In poisoning by carbon monoxide, asphyxiation takes place because carbon monoxide has 200 to 300 times as great an affinity for the hemoglobin of the blood as does oxygen. Thus even when present in the inspired atmosphere in only small concentration, it tends to displace oxygen. When the corpuscles become saturated with carbon monoxide there is no room for them to carry oxygen to the tissues, and asphyxia results. Unconsciousness results when the blood is about 60% saturated—this amount of saturation occurring in a very short

time—and death at any point after this. The maximum allowable concentration for an 8 hour workday, adopted by the American Conference of Governmental Industrial Hygienists, is 100 ppm.

*Identification.* TEST 1 (a) Dil NaOH. Place 2 drops of the patient's blood, and for comparison, 2 drops of a normal person's blood, on a porcelain plate. Add 2 drops of (a) to each. A pink precipitate slowly found indicates CO, (Kunkel's test) brown indicates no CO. TEST 2. (b) Aq. 2% palladous chloride. Soak filter paper in (b). Dry. Sandwich this test paper between two strips of cellophane (Scotch) tape, for it is sensitive to hydrogen sulfide and hydrogen in illuminating gas. Just before use, remove one of the pieces of tape. This paper exposed to carbon monoxide, hydrogen sulfide, gasoline vapors, etc. will turn gray (compare the color of the exposed strip with that of a covered strip).

*Symptoms.* Headache, giddiness, throbbing of the temples, nausea and vomiting, weak pulse, difficult breathing, loss of consciousness, death. There may be a bluish red color on various parts of the skin. At times the vomitus is drawn into the trachea and produces death by suffocation.

*Treatment.* Remove to fresh air and begin artificial respiration at once. If available, administer oxygen containing a mixture of 5 or 7% carbon dioxide. Keep the patient warm and quiet. Summon a physician.

Carbon Tetrachloride ( $\text{CCl}_4$ ) (see also page 163), benziniform, perchloromethane, or tetrachloromethane is manufactured by chlorine reacting with carbon disulfide in the presence of antimony trichloride catalyst. Carbon tetrachloride is a clear, colorless, noninflammable, heavy liquid having a characteristic odor like chloroform. In the presence of a flame or hot metal, carbon tetrachloride is partially converted into phosgene, a highly toxic war gas.

Carbon tetrachloride is used as a fire extinguisher, for rendering gasoline noninflammable, as a degreaser for metals, for cleaning clothes, and as a solvent for many substances such as oils and fats, waxes and resins, varnishes and lacquers, and rubber.

Carbon tetrachloride is taken internally in small doses (40 minims; 2.5 cc.) to cure hookworm, for which it seems specific. But it is never administered to alcoholics.

Vapors of carbon tetrachloride may give acute poisoning in concentrations of over 1000 ppm.; the threshold limit value for an 8-hour

workday adopted by the American Conference of Governmental Industrial Hygienists is 25 ppm. The minimal fatal dose of liquid lies between 3 and 4 cc.

*Identification.* Note the odor of carbon tetrachloride on breath or vomitus. To distinguish carbon tetrachloride from chloroform: (a) starch-iodide paper. Gently heat a drop of the unknown in a test tube for 1 minute. Then lower the moistened starch-iodide paper into the tube. Blue due to chlorine liberated from  $\text{CCl}_4$  acting on iodide indicates carbon tetrachloride. No color indicates chloroform.

*Symptoms.* Dizziness, headache, nausea, vomiting, subnormal temperature and a feeble pulse, coma, fever, uremia, death.

*Treatment.* Give no oils. Avoid alcohol in any form. If carbon tetrachloride vapors have been inhaled, give the patient fresh air or oxygen, and artificial respiration if necessary. If the liquid has been taken internally give 1 tablespoonful of Epsom salts in water; empty the stomach with an emetic of mustard and water; give a stimulant of hot, black coffee if the victim is conscious; administer artificial respiration if necessary. Keep the patient warm and quiet.

*External Treatment.* Wash thoroughly with soap and warm water.

Chloral Hydrate ( $\text{CCl}_3\text{CHO} \cdot \text{H}_2\text{O}$ ) is a hydrated aldehyde. It has a pungent odor and a bitter taste, and forms colorless crystals. Chloral is made by passing chlorine into absolute alcohol or aqueous acetaldehyde, and the hydrate is produced by adding water to chloral.

Chloral hydrate is used medicinally and in organic synthesis. It is the material known as knockout drops.

The fatal dose is extremely variable since 2 gm. has produced death, and on the other hand recovery has followed after 30 gm. were taken.

*Identification.* The breath often has the odor of bananas or pears. **TEST 1.** (a) Aq. sodium carbonate; (b) aq. saturated phloroglucin. One cc. of the unknown + 4 drops (a) + 1 cc. (b). Lilac to orange to red indicates chloral hydrate or aldehydes; chloroform gives no reaction (Schonbein's test). **TEST 2.** (c) Alcoholic potassium hydroxide; (d) aniline. Gently heat, with shaking, 2 cc. of the unknown liquid containing 1 cc. (c) + 1 cc. (d). The offensive odor of phenylisocyanide indicates chloral hydrate, chloroform, and other organic halogen compounds, such as iodoform.

*Symptoms.* About 15 minutes after taking the drug the victim feels tired, and drowsy, and falls asleep. On awakening there is nausea

and vomiting; contracted pupils; headache; sudden heart weakness; and a slow, feeble pulse; stupor; heart failure.

*Treatment.* Give no alcohol. Empty the stomach with an emetic of tannic acid or zinc sulfate; repeat the emetic using quantities of water; give black coffee as a stimulant to increase heart and respiratory action; apply artificial respiration if needed. Keep the victim warm and quiet.

*Other Poisons.* Butyl chloral hydrate, croton chloral hydrate, and chloral amide same treatment as for Chloral Hydrate.

Chlordane ( $C_{10}H_6Cl_8$ ) is a chlorinated hydrocarbon (indane derivative) insecticide consisting principally of octachlorohexahydromethanoindene. The technical product also contains some heptachlor and other chlorinated hydrocarbons. It is available in the form of wettable powders, emulsifiable concentrates, oil solutions, and low concentration dusts.

Chlordane is insoluble in water but is soluble in oils. It is readily absorbed through the skin. It is a stimulant of the central nervous system. The fatal dose for human beings is in the range of 6 to 60 gm. ( $\frac{1}{2}$  to 2 oz.) and serious symptoms will be exhibited on the ingestion, inhalation, or absorption of 15 to 50 milligrams.

Chlordane may be considered representative of the other chlorinated indane insecticides such as heptachlor, and chlorinated dimethanonaphthalene derivatives like dieldrin and aldrin. The latter is the most toxic of this group.

*Symptoms.* Some of the signs of poisoning by chlorinated indane insecticides are hyperexcitability, tremors, and convulsions which may occur before nausea and vomiting, weakness, depression, coma, and death from respiratory failure.

*Treatment.* Use gastric lavage with 2 to 4 quarts of tap water preceded by universal antidote, if available. If washing cannot be done, give 1 pint of milk or tap water and induce vomiting. Use 1 oz. of sodium sulfate as a cathartic. Give hot tea or coffee.

*External Treatment.* Make certain to wash the contaminated area of the skin thoroughly if poisoning resulted from skin absorption. If breathing is slow, assist it with artificial respiration or oxygen.

**Chlorinated Lime.** See Chlorine Water.

Chlorine ( $Cl_2$ ) (see also page 161) is a greenish-yellow gas obtained from common salt. One of our most important industrial gases,

chlorine is liquefied under pressure and shipped in tank cars to be used to purify water, to bleach cloth and wood pulp, and to make numerous industrial chlorinated products.

Fortunately chlorine has such an irritating odor that it gives ample warning of its presence. Its effect is merely temporary when breathed in moderate quantities; and recovery occurs after a short lapse of time. However, a concentration of 0.1% chlorine by volume will kill within a few minutes. A half-hour exposure to a concentration of 0.005% can cause serious injury and possibly death. The threshold limit for an 8-hour working day adopted by the American Conference of Governmental Industrial Hygienists is 1 ppm.

*Identification.* Note the odor of chlorine in breath or vomitus. Chlorine bleaches wet colored cloth. **TEST 1.** (a) Starch-iodide paper. Hold moistened paper in patient's mouth, or dip in vomitus. Blue indicates chlorine or bromine. **TEST 2.** (b) Aq. silver nitrate; (c) dil.  $\text{HNO}_3$ ; (d) dil. ammonium hydroxide. Two cc. of the unknown solution + a few drops (b) + 1 cc. (c). A white precipitate ( $\text{AgCl}$ ), dissolving to form  $\text{Ag}(\text{NH}_3)_2\text{Cl}$  if (d) is added carefully (shake after each drop is added) in excess, indicates chlorine.

*Symptoms.* Breathing chlorine causes edema of the lungs. The victim will find it difficult to breathe; the skin is pale, cold, and clammy, the chest tight, and the pulse weak.

*Treatment.* Remove the victim to fresh air; allow him to inhale ammonia fumes. Breathing fumes of ethyl alcohol brings speedy relief, possibly by paralyzing the nerves of the throat. Have the patient swallow starch or flour in water, then milk of magnesia, then white of eggs and milk, and finally an emetic of mustard or of zinc sulfate (30 to 60 grains) in water. Administer oxygen if available, preferably breathing through a small tube or pipe stem to create a positive pressure and drive the fluid back into the lung tissue. Keep the patient warm and quiet. See Chlorine Water.

Chlorine Water, produced by dissolving chlorine gas in water, is a clear, yellowish liquid having a suffocating odor. This solution is used as a disinfectant and deodorizer and as a bleach for wood pulp, paper, cotton fabrics, and many other textiles.

Chlorine water owes its activity to  $\text{HClO}$  (hypochlorous acid), which chlorine forms with water; the oxygen in  $\text{HClO}$  is available to bleach and disinfect, just as excess oxygen in hydrogen peroxide bleaches or disinfects. There are a number of other household bleaches contain-



ing compounds chemically similar to  $\text{HClO}$ . They include: eau de Javelle, La Barraque's, Dakin's, and Carrel's solutions, which are potassium salts or sodium salts of hypochlorous acid ( $\text{KClO}$  and  $\text{NaClO}$ ). Bleaching powder, or chloride of lime ( $\text{CaOCl}_2$ ), another common household disinfectant, similarly owes its action to the formation of  $\text{HClO}$  upon reaction with acid (e.g., vinegar).

*Identification.* Same as for Chlorine.

*Symptoms.* If chlorine water has been swallowed, the patient has a burning in the throat and stomach, nausea and vomiting, pallor, weak pulse, and difficult breathing.

*Treatment.* If chlorine water has been swallowed, have the patient sniff ammonia or ethyl alcohol; give starch or flour in water; then milk of magnesia; then milk or white of eggs, and finally an emetic. Keep the patient warm and quiet; apply external heat to the body and extremities.

*External Treatment.* If chlorine water has been spilled on the skin, wash thoroughly with plenty of water; if the skin has been reddened, apply a paste of baking soda and water.

*Other Poisons.* Bromine and bromine water call for the same treatment as for Chlorine or Chlorine Water.

Chloroform ( $\text{CHCl}_3$ ), trichloromethane, or (incorrectly) formyl trichloride, is prepared by chlorine reacting with acetone or alcohol in the presence of lime; or by the reduction of carbon tetrachloride by hydrogen. Chloroform is a colorless, clear, sweet-tasting, heavy liquid possessing a characteristic odor. It is very volatile.

Chloroform is used industrially as a solvent for waxes, fats, and oils; for alkaloids; and in the rubber industry.

Chloroform is administered internally to check vomiting, seasickness, diarrhea, hiccup, tapeworm, and colic. It is inhaled as an anesthetic to check convulsions as in epilepsy, asthma, and strychnine poisoning. Externally a 20 to 50% liniment is applied to soothe rheumatic and other local pains.

Dangerous symptoms do not appear unless an excessive quantity has been taken. The normal dose is 5 minims or 0.3 cc., usually diluted with alcohol, soap liniment, or water. A concentration of chloroform vapor of 80% by volume will kill in a few minutes. A  $\frac{1}{2}$ -hour exposure to 1.5% may be lethal. Swallowing  $1\frac{1}{2}$  oz. of liquid chloroform may prove fatal.

*Identification.* The odor of chloroform on the breath. (a) Pyridine;

(b) aq. NaOH. Unknown 2 cc. (a) + 2 cc. (b). Boil for 1 minute. Pink to deep red indicates chloroform. See the test under Carbon Tetrachloride for distinguishing it from chloroform.

**Symptoms.** When too much chloroform is given, the following symptoms result: a slow, weak, and irregular pulse; pallor; dilated pupils having no reaction to light; a still further slowing of breathing and pulse; and finally death, from paralysis of the heart.

**Treatment.** If chloroform has been inhaled, stop its use. Administer oxygen with 5% carbon dioxide mixture; apply artificial respiration; alternate hot and cold water to the face and chest. If the liquid has been swallowed, give 4 oz. mineral oil followed by stomach lavage with large amounts of water, and in addition use stimulants such as tea or coffee if the patient is conscious. Keep the patient warm and quiet. Give an emetic of mustard and water.

**Other Poisons.** Ether and laughing gas (nitrous oxide) call for the same treatment as for Chloroform.

**Chloropicrin.** See page 166.

**Cocaine** ( $C_{17}H_{21}O_4N$ ) or methylbenzoyl ecgonine is an alkaloid obtained from the leaves of the *Erythroxylon coca* and other *Erythroxylon* shrubs growing in South American countries. It forms colorless crystals or powder. This drug is easily decomposed and reacts to form many artificial alkaloids.

Cocaine is more often used in the form of cocaine hydrochloride (cocaine muriate, incorrectly called cocaine hydrochlorate). Either form is rarely administered internally. Externally they are used to relieve pain and to check bleeding. Since cocaine preparations paralyze the nerve endings, minor operations are possible by deadening the feeling in the area affected.

The normal dose is  $\frac{1}{8}$  to 1 grain (10 to 60 mg.). One gram may produce death when taken by the mouth; 0.03 gram by the urethra.

**Identification.** (a) Aq. potassium dichromate; (b) conc. HCl. Add a few drops of (a) to an aq. solution of the unknown. A yellow precipitate which dissolves on shaking indicates cocaine. Now add a few drops of (b). Orange-yellow needles precipitate when cocaine is present (Metzger's test).

**Symptoms.** Shortly after the absorption of a large dose the victim experiences restlessness, pallor, cold sweat, and a dry throat. He may feel joyful and happy. The pupils are dilated. There may be nausea

and vomiting; clonic or tonic convulsions follow. Subsequent symptoms that indicate that the patient's life is in danger are a rapid pulse becoming slow and weak; rapid respiration becoming shallow and slow; more frequent convulsions; and coma. Finally, there is fatal collapse.

*Treatment.* If cocaine has been swallowed, give tannic acid followed by an emetic to evacuate the stomach; reassure the patient; give medicinal charcoal and ammonia by inhalation; apply ice to the head. Treat convulsions by inhalation of ether or chloroform. Keep the patient warm and quiet.

Codeine ( $C_{18}H_{21}O_3N \cdot H_2O$ ) or methylmorphine is an alkaloid obtained from opium or by the methylation of morphine. Codeine forms a colorless, odorless white crystalline powder or crystals. It is used as a free alkaloid, and as the sulfate or other salts, as a hypnotic, sedative, and substitute for morphine as an analgesic. The normal dose of codeine sulfate is  $\frac{1}{2}$  grain or 0.03 gm. Amounts of 4.5 grains or more are dangerous.

*Identification.* (a) Molybdic acid, (b) conc.  $H_2SO_4$ . To 2 mg. (about the size of a rice grain) of the unknown add 1 cc. of (a) + 1 cc. of (b). Blue indicates codeine or morphine. Red indicates brucine. Yellow indicates aconitine. Green indicates apomorphine.

*Treatment.* The best known chemical antidote is potassium permanganate, given orally (10 grains in a pint of warm water), and repeated in  $\frac{1}{2}$  hour. Do not allow the patient to go to sleep, but avoid exercise such as walking to keep him awake. Give strong black coffee. Put ice on the head, and apply external heat to the extremities. Apply artificial respiration, using oxygen if necessary. The physician will administer respiratory stimulants if he deems it necessary.

*Other Poisons.* Laudanum, morphine, opium, and paregoric call for the same treatment as for Codeine.

Copper (Cu) is a reddish, lustrous, malleable metal. It is produced in the form of sheets, wire, ingots, or powder and is not toxic in the metallic state. Some of the salts, however, are occasionally the cause of fatal poisoning. The copper salts of toxicologic significance follow.

CUPRIC ACETATE and other acetates, such as copper subacetate, green verdigris, are greenish-blue powders, have a faint acetic odor, and are used as an escharotic, and also in the manufacture of Schwein-

furt green and other pigments, in insecticides, in dyeing and printing fabrics, etc.

**COPPER ACETOARSENITE**, Schweinfurt, Imperial, Vienna, Parrot, or Paris green is an emerald-green powder used as a pigment, particularly against barnacles on ships and submarines, and as an insecticide and wood preservative.

**CUPRIC ARSENITE**, copper arsenite, Scheele's mineral, or Swedish green is a yellowish-green powder used as an insecticide and base for many green copper pigments.

The fatal amount is uncertain since a portion is usually vomited. Most cases survive a few days but one victim died in a few hours from  $\frac{1}{2}$  ounce of the subacetate.

**CUPRIC SULFATE** ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ), bluestone, blue copperas, blue, Roman, or Salzburg vitriol is blue, transparent, large crystals or blue granules or light powder. It is used as an escharotic, styptic, astringent, and emetic, and also in dyeing cotton and silk, tanning leather, engraving, destroying algae in pools; in copper soap, tin-marking ink, hair dye, insecticide mixtures, electric batteries, etc.

*Identification.* **TEST 1.** See page 17, spot tests. Cupric salts in water solution are blue, or greenish-blue. **TEST 2.** (a)  $\text{NH}_4\text{OH}$ . Unknown aq. solution + (a) in excess. Deep blue or purple solution indicates copper. **TEST 3.** (b) Potassium ferrocyanide. Unknown aq. solution + (b). The red precipitate of  $\text{Cu}_2\text{Fe}(\text{CN})_6$  indicates copper.

*Symptoms.* Nausea and vomiting of greenish material, diarrhea with dark green stools, symptoms of collapse and heart failure.

*Treatment.* Summon a physician. The chemical antidote is the yellow prussiate of potassium (potassium ferrocyanide) 5 to 15 grains in water; or sodium thiosulfate. Evacuate the stomach; give raw eggs and milk abundantly, and plenty of water; apply external heat.

**Cresols** ( $\text{CH}_3\text{C}_6\text{H}_4\text{OH}$ ) or hydroxytoluenes, of which there are three, are present in coal tar, but are usually manufactured from other coal-tar intermediates. A number of disinfectants, germicides, and antiseptics on the market contain mixtures of these cresols suspended in water or oil. All of them are much more dangerous than phenol (which chemically is the same as the cresol molecule only with H substituted for the  $\text{CH}_3$  group). Usually some phenol is also present as an impurity.

**CREOLIN**, **CREOLIN-PEARSON**, or **CRESOTAL** is a water emulsion of coal-tar phenolics used in a 1 to 3% solution as a deodorant, disinfectant,

and germicide; 1 to 2% solutions have been used for sterilizing cuts.

**CREOLIN VETERINARY** is a 2% aqueous or 10% oil emulsion for cuts, ulcers, and parasite wash for animals.

**WOOD CREOSOTE** is a mixture of phenolics, particularly creosol (4-hydroxy-3-methoxy-1-methylbenzene) and guaiacol (methylcatechol). It was first obtained from beechwood tar. Internally it is used for diarrhea, seasickness and stomach disorders; and is also inhaled for such lung troubles as tuberculosis or bronchitis. Externally the dilute solution has been used for chilblains and ulcers.

**COAL-TAR CREOSOTE** on the other hand contains more poisonous phenolics from coal tar, they are in the fraction which distills in the range 230-270° C. The investigator should confirm, if a physician has prescribed creosote to be taken internally, that only wood creosote and not coal tar creosote has been taken. It is just such errors as these that the investigator must be careful to distinguish. Approximately seven grams is considered a fatal dose.

**CRESOL, CRESYLOL, or TRICRESOL** is a colorless, yellowish, brownish-yellow, or pinkish liquid, which darkens on age; it has a phenolic odor. Cresol is used as a disinfectant and antiseptic and is alleged to be 36 times more powerful than phenol. Normal dose is 1 minim or 0.06 cc. The fatal dose is approximately the same as for phenol.

**LYSOL**, a registered trade mark for a disinfectant and antiseptic containing essentially soap, cresylic acid and orthohydroxydiphenyl. As a disinfectant (for walls, floors, etc.) it is used in 1% solutions. As an antiseptic (for douches, irrigations, etc.) it is used in 1/2% solutions.

*Identification.* Same tests as for Phenol.

*Symptoms.* Burns on the mouth and lips; pain in the throat and stomach; nausea and vomiting; headache and dizziness; pallor; cold, moist skin; collapse.

*Treatment.* Use sodium bicarbonate solution for gastric lavage. Use no oils, fats, or greases. Give an emetic or 60 grains of zinc sulfate in a glass of warm water, and immediately follow with one tablespoonful of Epsom salts in water; finally administer raw eggs and milk to protect the membranes; treat collapse with heat stimulants. Keep the patient warm and quiet.

*External Treatment.* Washing the burns with alcohol or whiskey is commonly recommended in the textbooks, but according to F. R. Davison is of doubtful value because the alcohol solution of cresol will itself be quickly absorbed into the system. If there is so much

cresol on the burn that an alcohol wash is imperative (1) wash thoroughly with water, (2) give a rapid alcohol or whiskey flush, and (3) within a few seconds wash off the alcohol solution with more water. It is *absolutely essential* to follow these steps in the order given.

*Other Poisons.* Creosote, cresols, guaiacol, and other phenolic coal-tar products call for the same treatment as for Phenol.

**Croton Oil** or *oleum tiglii* is a thick, yellowish fixed oil (an oil that does not evaporate) pressed from the seeds of the *Croton tiglium* L., a shrub found in parts of southern Asia.

Croton oil is given by some physicians internally, in diluted form, to persons unwilling or unable to swallow medicine; to mentally disturbed persons who refuse to swallow medicine; and in cases of apoplexy when the patient is unconscious. Externally a 50% solution in sweet oil is rubbed on locally for colds, for rheumatism, and for toothache.

*Identification.* Oily. Blisters the skin.

*Symptoms.* Pallor, severe griping pains, violent purging and collapse. It causes redness and irritation on the skin and may cause blisters on mucous membranes.

*Treatment.* Evacuate the stomach with an emetic, give plenty of water, apply external heat, and give raw eggs and milk.

**Cyanides.** See Acid, Hydrocyanic, page 39.

**2,4-D**, 2,4-dichlorophenoxyacetic acid ( $C_6H_3Cl_2 \cdot OCH_2COOH$ ) and its salts like sodium 2,4-dichlorophenoxyacetate and the alkanolamine dichlorophenoxyacetates are among the most widely used herbicides or weed killers. Millions of pounds of these substances are used yearly for the destruction of weeds and harmful plants like poison ivy.

While the action of these substances on human beings is not too well known, it appears that they can kill mammals, including monkeys, death being due to ventricular fibrillation. Contact with the skin and inhalation should be avoided.

The acid is insoluble in water but is soluble in organic solvents; the salts are soluble in water.

*Symptoms.* Irritation of the eyes, gastrointestinal disturbances, muscle stiffness, paralysis, coma, and death.

*Treatment.* Remove the herbicide by gastric washing. Give universal antidote, if available, and subsequently an emetic.

*External Treatment.* Wash the contaminated area of the skin thoroughly.

**D-D** is the symbol for a mixture of chlorinated hydrocarbons which include 1,3-dichloro-1-propene ( $\text{CH}_2\text{Cl}\cdot\text{CH}:\text{CHCl}$ ), 1,2-dichloropropane ( $\text{CH}_2\text{Cl}\cdot\text{CHCl}\cdot\text{CH}_3$ ), and related  $\text{C}_3$  hydrocarbons. This material is used as a soil fumigant for the control of nematodes, being injected into the ground. It has an odor resembling garlic and a dark brown color. The mixture is considered to be a very toxic material.

*Symptoms.* When ingested, strong abdominal pains and chest congestion; when inhaled, gasping, coughing, resistance to breathing, tearing of eyes, and respiratory distress.

*Treatment.* Remove the ingested material by gastric lavage with water. Give a demulcent like alumina gel and do not use any fats or oils or materials containing fats or oils, for these promote the absorption of the poison by the body.

*External Treatment.* Wash the contaminated areas of the skin very thoroughly with soap and water and discard all contaminated clothing.

**DDT**, 1,1,1-trichloro-2,2-bis-(*p*-chlorophenyl)ethane,  $[(\text{ClC}_6\text{H}_4)_2\text{CH}\cdot\text{CCl}_3]$  (the symbol stands for the synonym dichlorodiphenyltrichloroethane), chlorophenothane, is a chlorinated hydrocarbon (chlorobenzene derivative) insecticide. It was the first of the synthetic chlorinated hydrocarbon insecticides used on a very large scale and though it was first synthesized in 1874, it was not until 1939 that its insecticidal powers were noted. Many types of insect are no longer affected by this toxicant. Despite this fact, it is still the most widely used insecticide.

DDT acts on the central nervous system but the mechanism of its action is still not clear. It is readily absorbed from the intestinal tract and from the lungs. It is not directly absorbed through the skin, but if it is in solution in an organic solvent, it can be absorbed. It is known that a dose of 20 gm. ( $\frac{2}{3}$  oz.) is highly dangerous but not fatal to human beings. The estimated fatal dose is about 35 gm. for a 150-pound man. About 1.5 gm. will cause great discomfort and distinct symptoms.

*Symptoms.* The symptoms observed in persons who ate substantial doses of DDT in flour were, vomiting, numbness and partial paralysis of the extremities, hyperactive reflexes which appeared in 30 to 60

minutes after ingestion. Other symptoms are headache and convulsions, and in animals death has occurred.

*Treatment.* Give universal antidote and then gastric lavage with tap water, provided convulsions are not imminent. Use 15 to 30 gm. of sodium sulfate in water as a cathartic. Force fluids; give hot tea or coffee. Do not use oils or fats, or powerful stimulants like adrenaline.

*External Treatment.* Wash the contaminated area of the skin thoroughly with large quantities of soapy water.

Dieldrin is a chlorinated hydrocarbon insecticide, namely a hexachloroepoxyoctahydrodimethanonaphthalene, ( $C_{12}H_8Cl_6O$ ) which constitutes about 85% of the commercial product. It is a crystalline solid melting at about  $150^{\circ}C$ . It is insoluble in water and is soluble in many organic solvents. It acts on the central nervous system and is considerably more toxic than DDT. The symptoms caused by this material and the treatment are discussed in the section on Chlordane. Aldrin is a hexachlorohexahydrodimethanonaphthalene.

Digitalis, fairy gloves, foxglove, or purple foxglove is obtained from the dried leaves of the *Digitalis purpurea* L., Scrophulariaceae, found in southern and central Europe, and cultivated in the United States.

Various digitalis preparations, and their normal doses are as follows. (1) Difoline, solid in solution, of which 1 cc. is equivalent to  $\frac{1}{10}$  gm. digitalis; or 1 tablet to  $\frac{1}{10}$  gm. of the leaf; (2) digalen, a 26% alcohol solution, dose 1-2 cc.; (3) digitalinum verum, digitalinum true, or Schmiedeberg's digitalin ( $\frac{1}{30}$  grain); (4) Hormolle's digitalin (French), or chloroformic digitalin ( $\frac{1}{240}$  grain, then rapidly increased to  $\frac{1}{40}$  grain); (5) Walz digitalin (German) ( $\frac{1}{10}$  to  $\frac{1}{2}$  grain up to 1 grain); (6) digitalis U. S. P. XV (2 grains); (7) digitalon, an aseptic solution ( $\frac{1}{2}$  to 1 cc.); (8) digitan, a purified extract (1 cc. or  $\frac{1}{10}$  gm.); (9) digitonin or digitin, which has no heart action; and (10) digitoxin, the most active and toxic glucoside of the *digitalis purpurea* ( $\frac{1}{240}$  to  $\frac{1}{60}$  grain).

Digitalis is used as a stimulant in disease of the heart, especially with fibrillation; also to stimulate flow of urine.

Death can result from an overdose of the drug; 2.5 gm. of digitalis has been fatal; and only  $\frac{1}{10}$  grain of digitoxin has killed in a few hours.

*Identification.* May be in vomitus (a) Conc.  $H_2SO_4$ ; (b) bromine.



Unknown treated with (a). Green, not decolorized by (b) indicates digitoxin; orange-yellow, turning cherry or violet with (b) indicates digitalin. Red, intensified with (b) indicates digitonin. Emerald green turning brown indicates strophanthin.

*Symptoms.* Nausea and vomiting, diarrhea and pain in the abdomen; slow, weak, and irregular pulse; weakness; headache; poor vision; dizziness. The pulse becomes rapid at the slightest exertion.

*Treatment.* Evacuate the stomach with 60 grains of tannic acid to one pint of water; enforce absolute rest and quiet for several days; keep the patient warm and apply external heat, and heat to the region of the heart. Apply artificial respiration if necessary.

*Other Poisons.* Digitalin, digitoxin, ouabain, squill, strophanthin, strophanthus, and other digitalis preparations show the same symptoms and call for the same treatment as Digitalis.

Dinitro-*o*-Cresol, 4,6-dinitro-*o* cresol,  $(\text{CH}_3 \cdot (\text{NO}_2)_2 \text{C}_6\text{H}_2\text{OH})$  is a selective herbicide and insecticide. It is a yellow crystalline material that melts at  $87.5^\circ \text{C}$ . It is sparingly soluble in water, readily soluble in alkaline solutions, and is soluble in some organic solvents. The fatal dose is about  $\frac{1}{5}$  that of dinitrophenol, namely 0.2 gm. The symptoms exhibited in poisoning due to dinitro-*o*-cresol are similar to those detailed for dinitrophenol and the treatment is the same.

*Identification.* Dinitrocresol gives a red color when treated with metallic zinc in 10% HCl.

Dinitrophenol, 2,4-dinitrophenol  $[(\text{NO}_2)_2 \text{C}_6\text{H}_3\text{OH}]$  is used as an insecticide and herbicide. It was formerly used relatively commonly and is possibly still used on occasion for the reduction of obesity, even though it is known to be too poisonous for such use. Dinitrophenol is a yellow crystalline substance that melts at  $112\text{--}114^\circ \text{C}$ . It is soluble in water, 0.5 gm. in 100 cc., and is readily soluble in organic solvents and alkali solutions.

Dinitrophenol is a highly toxic material. The fatal dose is approximately 1 gm. and it is more toxic in hot weather. It can be absorbed through the skin.

*Identification.* Dinitrophenol may be detected in the urine. (a) 10%  $\text{H}_2\text{SO}_4$ ; (b) 0.5% sodium nitrite solution, (c) 0.5% beta-naphthol solution in ammonia; (d) ether. Add 1 cc. of 10%  $\text{H}_2\text{SO}_4$  and 1 cc. of 0.5% sodium nitrite solution to 10 cc. of the urine, shake to mix, and allow to stand in the dark for 5 minutes. Put 2 cc. of a freshly

prepared 0.5% solution of beta naphthol in ammonia in a 25-cc. test tube, add the treated urine, and shake to mix. Add 10 cc. of ether, shake, and stopper loosely. A violet, wine, or orange-red color is indicative of dinitrophenol.

**Symptoms.** Thirst, fatigue, excessive sweating, nausea, vomiting, stomach pains, high temperature, difficulty in breathing, restlessness, sometimes convulsions, prostration, tremors, coma, and death.

**Treatment.** Gastric washing with 5% sodium bicarbonate solution. Give 15 to 30 gm. of sodium sulfate as a cathartic. Try to cause vomiting if gastric lavage cannot be employed. Use cold compresses or even a cold bath to reduce fever. Give hot tea or coffee. Use oxygen, if necessary.

**External Treatment.** Remove contaminated clothing and wash thoroughly with soap and water.

Disulfiram  $[(CH_3CH_2)_2NCS \cdot S]_2$ , known by the trade name Antabuse, is used to discourage the drinking of alcoholic beverages. The drug has this effect by preventing the enzymic decomposition of ethyl alcohol at the acetaldehyde step in the cycle. The buildup of acetaldehyde in the body causes very unpleasant symptoms. Fatalities have occurred after the ingestion of from 0.5 to 1 gm. when the blood alcohol level was 100 milligrams per 100 cc.

**Symptoms.** Breathlessness, flushing, sweating, rapid heart action, nausea, vomiting, low blood pressure, difficulty in breathing, convulsions.

**Treatment.** Gastric washing, if it can be done promptly. Artificial respiration and oxygen.

Ergot, *secale cornutum*, or spurred rye is obtained from *claviceps purpurea*, a fungus growth that develops on rye plants in Europe. Ergot contains many alkaloids, some of which are ergocristine, ergonovine, ergosive, ergotamine, ergotinine, and ergotoxine. The mixture has a very unpleasant taste.

Ergot is given to check bleeding from the uterus or to contract the uterus in childbirth; in this latter use it is never administered until after the placenta has been expelled.

The normal dose is 8 grains or 0.5 gm. Since ergot preparations vary in their content it is difficult to state definitely the fatal dose. Death has resulted after 12 grains were taken; and on the other hand recovery has followed a dose of 150 grains.

*Identification.* With ergot the vomitus will have a nutty odor. (a) Ether; (b) dil. KOH; (c) aq. sodium oxalate, (d) conc.  $\text{H}_2\text{SO}_4$ . Prepare an extract of the unknown in (a). Test as follows. Portion 1: Heat (beware of ether near the flame) with (b). The fishy odor of trimethylamine indicates ergot. Portion 2. Unknown extract + (c). Red indicates ergot. Portion 3: (Tanret's test) Pour (d) upon unknown extract. At junction, orange turning blue indicates ergot.

*Symptoms.* Poisonous doses usually produce nausea and vomiting, cramplike pains low in the abdomen, diarrhea; an itching and tingling of the skin; slow, weak pulse; pain around the heart, shortness of breath; muscle spasms, and possible convulsions and coma before death.

*Treatment.* Wash out the stomach with an emetic (zinc sulfate, 20 grains) or mustard. Give a teaspoonful of medicinal charcoal, give a stimulant of hot black coffee. Keep the patient warm and quiet.

Ether ( $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$ ), diethyl oxide, ethyl ether, ethyl oxide, sulfuric ether, or sulfuric ethylic ether is a clear, colorless, very volatile and very inflammable liquid, with a burning taste and a characteristic odor. Vapors of this compound are explosive when mixed with air. Ether is manufactured by partially removing water from alcohol at  $135^\circ \text{C}$ . with sulfuric acid. (Hence the name sulfuric ether.) Ether is an important organic solvent for waxes, oils, fats, gums, perfumes, and for alkaloids; it is used in making dyes, collodion, and smokeless powder and for cleaning fabrics. It is stored in a copper-lined container, or a container having a spiral of copper wire, which prevents decomposition into substances that would impair its anesthetic properties.

Ether is taken internally to control spasms in hiccup and as a stimulant in fainting or collapse. Its most familiar use is as an inhalation anesthetic. Externally, ether is used in earache, toothache, and neuralgia, and to facilitate removal of adhesive tape in surgical dressings.

U.S.P. ether contains about 2.5 to 3.5% alcohol, and about 0.5% water.

The normal dose is 15 minims or 1 cc. As a vapor 3.5% by volume can produce unconsciousness. One ounce of liquid has proved fatal in minutes to hours. The maximum allowable concentration for an 8 hour working day adopted by the American Conference of Governmental Industrial Hygienists is 400 ppm.

*Identification.* Odor on breath.

*Symptoms.* Use of too much ether produces a slow, shallow, and gasping breath; the face becomes blue; blood pressure falls rapidly; pupils are widely dilated and do not react to light; pulse grows weaker; and death results from respiratory failure.

*Treatment.* If ether is being inhaled, stop its use; administer oxygen with a carbon dioxide mixture; apply external heat and artificial respiration if necessary; lower the head; have the victim inhale ammonia. If the liquid has been swallowed, give the same treatment as for inhaled gas, but also use an emetic.

*Other Poisons.* Chloroform and laughing gas (nitrous oxide) call for the same treatment as for ether. See Chloroform.

Ethylene Glycol ( $\text{HOCH}_2\cdot\text{CH}_2\text{OH}$ ), glycol, is a colorless, odorless, syrupy liquid with a sweetish taste. It boils at  $197^\circ\text{C}$ . and is miscible with water and alcohol. It is the principal "permanent" antifreeze used for the cooling systems of motor vehicles being sold under a number of trade names like Prestone, Zerex, etc. It is also used on a large scale industrially as an explosive intermediate, tobacco humectant, leather preservative, and for other uses.

It is met as a poison generally through the drinking, accidental or intentional, of antifreeze. The fatal dose is of the order of 3 to 4 oz. and a number of deaths have been recorded as due this material.

*Symptoms.* The symptoms attributable to the ingestion of large amounts are similar initially to those of intoxication by alcohol followed by depression, vomiting, cyanosis, stupor, prostration, coma, convulsions, renal damage, and death from respiratory failure.

*Treatment.* Remove the ingested material either by inducing vomiting or by gastric lavage. Give oxygen, if necessary.

**Fluorides.** See Sodium Fluoride.

**Fluoroacetates.** See Sodium Fluoroacetate.

Formaldehyde ( $\text{HCHO}$ ), formalin, formic aldehyde, formol, methanal, methylene oxide, or oxymethylene is made by the oxidation of methyl alcohol vapors with air over hot copper. Commercial "40% formalin" contains 40 gm. of formaldehyde per 100 cc. of solution; actually this amounts to 37% formaldehyde by weight. Formalin solutions become cloudy with age, or when hot or in the light; this is due to formation of a polymer, paraformaldehyde. To prevent this polymerization, commercial formalin usually contains 10 to 15% methyl alcohol.

Formalin is used in embalming fluids, for anatomical specimens, for hardening photographic film, in formaldehyde-phenol plastics, and elsewhere.

It is used as a germicide, antiseptic, and deodorant. A 0.5% wash is available for wounds and abscesses.

The vapors act chiefly on the upper respiratory tract. One ounce has caused death; the largest quantity from which recovery has been achieved is 2 oz. The maximum allowable concentration for an 8-hour working day adopted by the American Conference of Governmental Industrial Hygienists is 5 ppm.

*Identification.* Odor on the breath. (a) Aq. 5% phenylhydrazine hydrochloride, (b) aq. 0.5% sodium nitroprusside; (c) aq. NaOH. Mix 3 cc of the unknown liquid + 10 drops of (a) + 2 drops of (b) + 10 drops of (c). Blue, turning green, then yellow-red indicates formaldehyde. Red indicates acetaldehyde.

*Symptoms.* Nausea and vomiting, pallor, cold clammy skin, reddening of the eyes and mouth, a burning in the throat and stomach, and collapse.

*Treatment.* Empty the stomach with an emetic at once. Allow the patient to inhale ammonia fumes. Give a glass of water containing a few drops of ammonia as a chemical antidote. Give medicinal charcoal. Follow with raw eggs and demulcent drinks. Keep warm and apply external heat.

*External Treatment.* Wash thoroughly with water, then with aromatic spirits of ammonia, and again with water.

Gasoline ( $C_4H_{10}$  to  $C_{12}H_{26}$ ) really motor fuel (see pages 176, 179) is a mixture of several hundred hydrocarbons, saturated and unsaturated and many additives—tetraethyl lead, xylydine, catechol, benzene, toluene, ethylbenzene, tri-*o*-cresyl phosphate, and many other substances. While its chief hazard is explosion and fire it does have toxic properties. The maximum allowable concentration for an 8-hour working day adopted by the American Conference of Governmental Industrial Hygienists is 500 ppm. Leaded gasoline is extremely dangerous because of the tetraethyl lead it contains; also some gasoline containing high percentages of sulfur compounds may poison from the hydrogen sulfide present.

Although the greater part of manufactured gasoline is used as a fuel in motor vehicles, the liquid has many other uses, for instance, as a solvent for fats and oils, and in special lamps and stoves for light

and heat. Petroleum components are increasingly important as a starting material for many large-tonnage chemical industries: synthetic rubber, plastics, toluene, etc.

Death has been caused by a pint of this liquid.

*Identification.* Odor. Five drops on a bit of cotton burns with a smoky flame.

*Symptoms.* Headache, giddiness, a flushed face, a tendency to mania, nausea and vomiting, disturbed vision.

*Treatment.* Remove gasoline-soaked clothing. Empty the stomach at once with emetics. Apply external heat and keep the patient warm. Avoid alcohol or camphor as stimulants; use only black coffee or aromatic spirits of ammonia (1 teaspoonful in  $\frac{1}{2}$  glass of water). Apply artificial respiration and oxygen, if required. Rest is necessary.

*Other Poisons.* Benzene, kerosine, naphtha call for the same treatment as for gasoline.

**Heptachlor.** A chlorinated indane insecticide. See Chlordane.

**Heroin** ( $C_{21}H_{23}O_5N$ ), diacetylmorphine, or diamorphine, an artificial alkaloid made from morphine, is odorless, bitter white crystals or crystalline powder. It is usually taken by snuffing up the nose; but because heroin is so extremely habit-forming, manufacture of it and of its salts is prohibited in the United States.

Both it and the hydrochloride were formerly used internally as a sedative and antispasmodic against persistent cough, asthma, bronchitis, etc.

Death has been caused by 0.2 gm.

*Identification.* (a) Conc.  $HNO_3$ . Add 1 cc. water to 1 cc. (a). Shake with a pinch of the unknown powder. A yellow solution gradually changing greenish-blue, then turning bright yellow (changes are rapid on heating) indicates heroin. Heroin reacts with water to form morphine, and therefore responds to many morphine tests.

*Symptoms.* Following a poisonous dose the symptoms are similar to those of morphine; a slow pulse; slow, shallow breathing; pupils contracted to a pin point; cyanosis; stupor; sleep; coma, profuse perspiration; collapse.

*Treatment.* Wash out the stomach immediately with a potassium permanganate solution, which makes the drug inactive. Repeat washing every 30 minutes until the patient is out of danger; follow each washing with an emetic of 1 tablespoonful of mustard in a glass of

water. Apply artificial respiration if necessary. Keep the patient warm, quiet, and awake.

**Hydrogen Peroxide ( $H_2O_2$ ),** hydrogen dioxide or dioxygen, is manufactured by the action of dilute sulfuric acid or of carbon dioxide on ice-cold barium dioxide in water. The household variety is a colorless, bitter to sweet, 3% aqueous solution inhibited against decomposing by a trace ( $\frac{1}{16}$  grain per pint) of acetanilid. In industry a concentrated, dangerously caustic solution is used, one of which, Superoxol or Perhydrol, is a 30% aqueous solution. Hydrogen peroxide is used extensively as a bleaching and oxidizing agent in many chemical industries.

Hydrogen peroxide in concentrations of over 90% is commercially available, and a 99% hydrogen peroxide is used as the oxidizer in liquid propellant systems for rockets. The maximum allowable concentration for 90% hydrogen peroxide is 1 ppm.

Medicinally the 3% solution is used as a cleansing agent, antiseptic, and deodorant as in gargles, or applied to abscesses, tonsils, etc.; for bleaching teeth; and for counteracting certain toxins.

The normal dose is 60 minims, or 4.0 cc. of the 3% solution.

**Identification.** (a) Solid manganese dioxide. To the unknown solution add a pinch of solid manganese dioxide. Bubbling with a gas coming off (oxygen) that causes a glowing splint to burst into flame, indicates hydrogen peroxide.

**Symptoms.** Nausea and vomiting, pallor, and a weak pulse.

**Treatment.** Empty the stomach with an emetic, keep the patient warm by applying external heat

**Hydrogen Sulfide ( $H_2S$ ),** stink damp, or sulfuretted hydrogen is the familiar gas that smells like rotten eggs often noticeable in analytical chemistry laboratories. It is manufactured by the action of acid on ferrous sulfide, and is also found in flue gases, coal gases, and other gases of organic origin.

It is used extensively as a chemical reagent in qualitative analysis, since it forms characteristic colored sulfides, by which a mixture containing unknown metals may be identified.

Hydrogen sulfide is a deadly poison, which ranks with hydrogen cyanide in danger. One part of the gas in 200 parts of air is fatal to man. The threshold limit for an 8-hour workday adopted by the

American Conference of Governmental Industrial Hygienists is 20 ppm.

*Identification.* Odor of decomposing eggs. (a) Lead acetate paper. Paper (a) held to gas turns black (PbS) immediately indicates hydrogen sulfide.

*Symptoms.* Long exposure to small concentrations causes headache; dizziness; nausea; burning throat and cough; cramps; dilated pupils; greenish face, slow, weak pulse; coma; convulsions; and respiratory failure. High concentrations cause sudden unconsciousness, and death.

*Treatment.* Remove to fresh air; apply artificial respiration; if available administer oxygen. Keep the victim warm and quiet.

**Hypochlorites.** See Chlorine and Chlorine Water.

Iodine ( $I_2$ ) is a steel-gray, nonmetallic element obtained industrially as an impurity from Chile saltpeter; some iodine is also obtained from California brines and seaweed ashes. It is used in photography, in manufacturing iodine compounds, and as an analytical reagent.

Iodine is given internally in goiter cases to counteract a deficiency of the thyroid gland; and as an antidote in phenol and cresol poisoning. Externally the most important application is in tincture of iodine, used on cuts and abrasions; and applied to external portions of the body as in lumbago, chilblains, ringworm, etc. There are many tinctures of different strengths. A strong tincture may contain as much as 16% iodine. On the other hand Lugol's solution is a mild water solution containing 4.5 to 5.3% free iodine made soluble by 10% potassium iodide; a few drops of this solution in water is used as an antidote (followed by gastric lavage) in poisoning by alkaloids. One ordinary household type of tincture of iodine contains 2% iodine and 2.4% sodium iodide in ethyl alcohol.

The average dose for the 2% tincture when used internally is about 5 minims, or .03 cc. One to 2 gm. of iodine is considered the fatal dose, although recovery has followed after a dose containing the larger amount.

*Identification.* Look for iodine or iodides in vomitus. **TEST 1.** (a) Chloroform; (b) chlorine water. Vomitus + (a). Violet extract indicates iodine. If the extract is colorless add (b). Violet extract indicates iodides. **TEST 2.** (c) Starch, such as flour or potato, is turned blue-black by iodine.



*Symptoms.* Metallic taste in the mouth; sense of heat in the throat and stomach; nausea and vomiting; diarrhea; rapid, weak pulse; cold, moist skin; shallow breathing; dilated pupils; cyanosis; convulsions; collapse.

*Treatment.* Give starch or flour and plenty of water; empty the stomach with an emetic; apply external heat; use stimulants (black coffee, or aromatic spirits of ammonia); followed with demulcent drinks and raw eggs, keep patient quiet.

*External Treatment.* Wash with alcohol, then soap and water.

Iodoform ( $\text{CHI}_3$ ) or triiodomethane is prepared from a dilute aqueous solution of sodium iodide in acetone, either by electrolysis in the presence of sodium carbonate or by addition of alkaline sodium hypochlorite. Iodoform is a yellowish crystalline powder, readily identified by its characteristic odor and sweetish taste.

It is used chiefly externally as an antiseptic for cuts, and to stimulate the growth of tissue.

Dose is 4 grains or 0.25 gm. Two grams of iodoform has caused death; and recovery has sometimes followed after 7 gm. had been taken.

*Identification.* Characteristic sweetish "hospital" odor. Note under Chloral Hydrate that TEST 2 which gives phenylisocyanide, is a test also for iodoform.

*Symptoms.* Iodoform after being absorbed into the blood produces the following poisonous effects. In mild cases there is only a rise in temperature, headache, rapid pulse, and dizziness. In severe cases the patient believes he is being persecuted, and may attempt suicide; collapse may cause death.

*Treatment.* Sodium bicarbonate (baking soda) is given with plenty of water, followed by an emetic to empty the stomach. Keep the patient quiet and warm, and ease his mental attitude.

*Isopropyl Alcohol.* See Alcohol, Isopropyl.

Kerosine or, as it is more commonly spelled, kerosene is a petroleum distillate and thus is a mixture of hydrocarbons. It boils in the range of 175 to 325° C. It is used as an insecticide and solvent for insecticides; as a fuel for lamps, stoves, flares, and diesel engines; and as a dry-cleaning agent. The ingestion of 10 cc. of kerosine and related petroleum distillates, such as gasoline, naphtha, benzine, Stoddard solvent, diesel oil, fuel oil, and like materials, may be fatal. Every

year some fatalities are reported as resulting from the ingestion of these materials, though as much as 240 cc. (8 oz.) has been ingested with recovery. See Gasoline for symptoms and treatment.

Lead (Pb) (see also page 172 and White Lead) is a flexible, heavy, bluish-gray, soft metal used in the manufacture of lead salts, shot, Babbitt and type metal, foil, solder, cable coverings, storage battery plates, etc.

Lead salts are rarely used internally because of the danger from lead poisoning. Externally they are applied as astringent and antiseptic lotions (acetate, nitrate, phenolsulfonate, and tannate); for skin diseases (carbonate); as irritant and counterirritant (iodide); in ointments (monoxide); and as a dusting powder (stearate).

Acute lead poisoning is rare. Chronic poisoning is caused by continued absorption of small quantities. It is dangerous because of accumulative effects on the blood vessels, heart, kidneys, and nervous system.

Tetraethyl lead is a very poisonous organic compound that is added to gasoline to increase its antiknock value.

No fatal dose for lead compounds can be definitely established. A soluble salt like the acetate may be lethal in amounts over 10 gm.; and cases of recovery have occurred when about 30 gm. were taken. The patient may die from collapse on the second or third day.

*Identification.* TEST 1. See page 17, spot tests. Lead iodide is a bright yellow. TEST 2. (a) Aq. potassium dichromate; (b) dil. acetic acid; (c) litmus paper. Three cc. water solution of unknown (preferably clear) + a few drops of (a). Add (b) until acid to litmus paper; a yellow precipitate of lead  $PbCrO_4$  (lead chromate) indicates lead.

*Symptoms.* Victim may have headache, delirium, excitement, convulsions, blindness, paralysis, coma, and a blue or black lead line on the gums, and collapse.

*Treatment.* Give 2 tablespoonfuls in  $\frac{1}{2}$  glass of water of Epsom salts (magnesium sulfate) or Glauber's salt (sodium sulfate). Follow with emetics, demulcent drinks, and stimulants.

Lime. See Calcium Oxide.

Lye (NaOH). See Sodium Hydroxide.

Lysoform is a mixture of formaldehyde and phenols and is used primarily as a disinfectant in 5 to 10% solutions. Even these concentrations are dangerous; not too great amounts will produce death.

*Identification.* See tests for (1) formaldehyde and (2) phenols.

*Symptoms.* Lips and mouth will be burned. Severe pain in the throat and stomach, pallor, nausea and vomiting, and collapse.

*Treatment.* Evacuate the stomach immediately with plenty of Epsom salts followed with an emetic; give raw eggs and milk and stimulants. Keep the patient quiet and warm.

*External Treatment.* Wash thoroughly with water, then with lemon juice or vinegar, and again with water.

*Lysol.* See Cresols, for which the symptoms and the treatment are the same.

**Malathion**  $[(CH_3O)_2PS \cdot SCH(CH_2COOC_2H_5) \cdot COOC_2H_5]$ , *O,O*-dimethyl *S*-(1,2-dicarbethoxyethyl) phosphorodithionate, is a phosphate ester insecticide that is available as technical grade material, 25% wettable powder, dusts, solutions, poison baits, and emulsifiable concentrates. While its toxicity is considered to be of a lower order than that of other cholinesterase poisons, it is still considered harmful, with an estimated toxic dose of 1 gm. See Parathion for symptoms and treatment.

**Mercury (Hg) or quicksilver** is a heavy, silvery liquid metal obtained from red cinnabar. Two well-defined series of compounds are known, namely mercurous and mercuric. Many of these compounds are medicines; they are freely used to commit suicide and homicide, as well as taken by accident or erroneously. Salts most likely to be encountered are:

**MERCURIC OXIDE** (red precipitate and yellow precipitate). There is both a red and a yellow modification of the oxide; both are heavy powders, practically insoluble in water or alcohol. They are used in ointments for skin diseases.

**MERCURIC CHLORIDE AMMONIATED**, ammoniated mercury, white precipitate, or aminomercuric chloride, is a heavy, white powder.

**MERCUROUS CHLORIDE**, calomel, mild mercury chloride, mercury mono-, proto-, or subchloride, is a heavy, white powder.

**MERCURY BICHLORIDE**, mercuric chloride, corrosive sublimate, mercury-perchloride, or corrosive mercury chloride, is in the form of colorless crystals, white granules or powder. It is generally sold in the form of blue, coffin-shaped "poison tablets" of 7.5 grains or small 2-grain tablets for use as a disinfectant. The average dose of mercury

bichloride (corrosive sublimate) when administered internally is  $\frac{1}{15}$  grain, or 0.004 gm.; that is, it is extremely poisonous.

The investigator should be particularly on the alert to ascertain whether mercuric chloride (corrosive sublimate), which is extremely poisonous, has been used by mistake as a laxative in place of mercurous chloride (calomel) which is not so poisonous.

*Identification.* Mercury compounds are in the stomach and intestines for first few hours; after a day they are mostly in the liver and kidneys; and after 4 days they have been eliminated. **TEST 1.** See page 17, spot tests. **TEST 2.** (a) Conc.  $\text{HNO}_3$ ; (b) conc.  $\text{HCl}$ ; (c) fresh aq. stannous chloride. Dissolve the unknown in a mixture of 1 cc. (a) + 3 cc. (b). A few drops of (c) giving gray ( $\text{HgCl} + \text{Hg}$ ) to black ( $\text{Hg}$ ) indicates mercury. **TEST 3.** The Reinsch test described for arsenic salts works equally well for mercury salts.

*Symptoms.* Mercury poisoning occurs in two forms: chronic and acute. The symptoms resulting from swallowing a poisonous mercury compound, such as bichloride of mercury in solution or in tablet form are: a burning pain in the throat; a metallic taste in the mouth; cramplike pains in the abdomen; nausea and vomiting; rapid, weak, and irregular pulse; pallor; cold, moist skin; shallow and slow breathing; diarrhea; collapse. Coma and convulsions may occur before death. Death results from excessive vomiting and diarrhea, which causes collapse.

*Treatment.* While the preferred antidote for mercury, arsenic, and gold is BAL, that is, 2,3-dimercapto-1-propanol or dimercaprol ( $\text{CH}_2\text{SH} \cdot \text{CH}_2\text{SHCH}_2\text{OH}$ ), which is available as a 10% solution in oil in 5-cc. ampules, equivalent to  $2\frac{1}{2}$  doses, since BAL has to be administered by intramuscular injection, it may be best in the case of an emergency to use the former preferred antidote—sodium formaldehyde sulfoxylate, which comes in 10-gm. ampules. This is also sold as formaldehyde hydrosulfite, formaldehyde sodium sulfoxylate, Formopan, Hydrolit, or Rongalit. Dissolve 1 ampule in 250 cc. of water; have the victim swallow this or introduce it with a stomach tube; then immediately empty the stomach. Dissolve another ampule in 250 cc. of water, have the victim swallow, and leave in the stomach. Apply external heat. If the sodium formaldehyde sulfoxylate is not available, give an abundance of raw eggs followed by an emetic of mustard or zinc sulfate (30 to 60 grains) in water.

**Methanol.** See Alcohol, Methyl.

**Methyl Alcohol.** See Alcohol, Methyl.

**Methyl Salicylate** ( $\text{HOC}_6\text{H}_4\text{COOCH}_3$ ), artificial or natural oil of wintergreen or betula oil, sweet birch oil or teaberry oil is a liquid with a wintergreen odor. The natural oils are obtained from the leaves of *Gaultheria procumbens* and from the bark of *Betula lenta*. It boils in the range of 220 to 224° C., is slightly soluble in water, and is miscible with alcohol. This substance is used as a flavor for candies and beverages like root beer, birch beer, and sarsaparilla, and medicinally as a skin counterirritant in from 10 to 50% in ointments and liniments. It can be absorbed through the skin. In a report in 1953, it was noted that it was responsible for the deaths of 36 of 54 deaths from the ingestion of volatile oils by children. The lethal dose varies from 10 cc. for a child to 30 cc. for an adult.

**Identification** The characteristic odor of oil of wintergreen.

**Symptoms.** See Aspirin.

**Treatment.** See Aspirin.

**Morphine** ( $\text{C}_{17}\text{H}_{19}\text{O}_3\text{N}\cdot\text{H}_2\text{O}$ ), morphia, or morphina is the most important alkaloid obtained from opium. It forms white, bitter, lustrous prisms, fine needles, or crystalline powder, which darkens upon exposure to light.

Morphine and particularly morphine sulfate and other salts are commonly used to lessen pain, calm nerves, induce sleep, and quiet muscles. When administered by hypodermic its action is more rapid than when taken by ingestion. It is given internally only in very serious cases, because in many instances complications attend its use.

The dose of morphine sulfate is  $\frac{1}{8}$  grain or 0.008 gm.; the fatal dose in a person who is not an addict is about 2 grains. The poisoning action is much faster in children. Most of the cases of morphine poisoning result from the administration of an overdose.

**Identification** **TEST 1.** (a) Neutral 5%  $\text{FeCl}_3$  solution. Add a few drops of (a) to the unknown powder. Blue, which may fade indicates morphine; red changing to black indicates apomorphine; no color is given by heroin or codeine. **TEST 2.** (b) Iodic acid; (c) chloroform; (d) dil  $\text{NH}_4\text{OH}$ . Warm 2 cc. (b); add a few drops of the unknown; shake; add an equal volume of (c), shake; let stand. A brown which deepens if a few cc. of (d) are added indicates morphine.

**Symptoms.** Physical ease and mental stimulation, with a quickened

pulse, which lasts a variable length of time. This is followed by drowsiness, nausea, a desire to sleep, a gradual loss of muscular power and sensitivity, and contracted pupils; stupor grows deeper; and death occurs in a deep coma.

**Treatment.** Potassium permanganate (10 grains) in a pint of warm water; repeat in  $\frac{1}{2}$  hour. Do not allow the patient to sleep, but avoid exercise such as prolonged walking. Apply artificial respiration if necessary for 24 hours; apply heat; give strong black coffee. Apply ice to the head and heat to the body extremities.

Mushrooms are a type of fungus growth. The species *Agaricus campestris* is edible, having been successfully cultivated for over 200 years. It grows only in open breezy pastures. The poisonous species *Amanita phalloides*, commonly called "toadstools," grows in wet, boggy places, in woods, and around tree stumps; it causes nine-tenths of all deaths from poisonous mushrooms.

Upon breaking mushrooms open, the edible variety remains white, whereas the poisonous species often turns buff or brown.

**Symptoms.** Acute abdominal pains, vomiting, diarrhea, constipation at times; cold, clammy skin; cyanosis; jaundice; convulsions; coma; death.

**Treatment.** Give an emetic of mustard or zinc sulfate (30 to 60 grains) in water; apply external heat, and administer oxygen if necessary. Stimulants should be administered if a need for them is indicated.

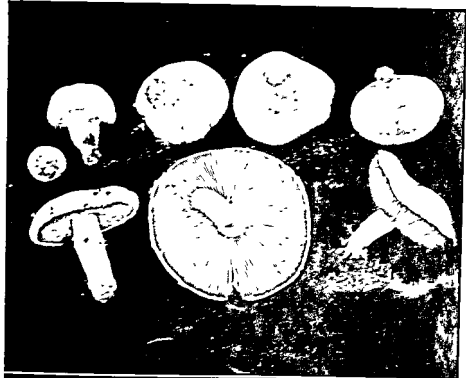
Naphthalene ( $C_{10}H_8$ ), naphthalin or tar camphor, is a white crystalline coal-tar product. It is an important starting point for the manufacture of indigo and other dyes, synthetic resins, organic acids, celluloid, and smokeless powder. Moth balls are pure naphthalene. Another household moth and insect repellent is paradichlorobenzene. Moth balls are not deadly poison, but swallowing them can cause great discomfort.

**Identification.** By the characteristic odor of moth balls.

**Symptoms.** Restlessness, depression, twitching, convulsions, urine dark brown to black, coma with snoring.

**Treatment.** Give an emetic; give demulcent drinks such as milk or oatmeal gruel, and stimulants if necessary.

Nicotine ( $C_{10}H_{14}N_2$ ), nicotia, or pyridyl-*N*-methylpyrrolidine, present in from 2 to 8% in tobacco leaves, is a very bitter, colorless to





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yellowish oily liquid, turning brown in the air. The liquid has a disagreeable odor, like pyridine. Solutions containing about 1% nicotine are used as a spray against plant lice and against the itch-mite in sheep. A relatively common insecticide is "Black Leaf 40," which contains approximately 40% nicotine sulfate. One drop of pure nicotine has killed in 15 minutes to an hour.

**Identification.** Strong tobacco odor. **TEST 1.** (a) Ordinary "formalin" containing 37% formaldehyde; (b) conc.  $\text{HNO}_3$ . To 10 mg. of the unknown residue add 1 drop of (a), then a drop of (b). A rose color indicates nicotine, and is not given by aniline, coniine, or pyridine. **TEST 2.** (c) Chlorine water. Unknown solution + (c). A red-brown precipitate indicates nicotine.

**Symptoms.** With large doses, tremors; palpitation; pupils first contract, then dilate; headache, dizziness; collapse and coma due to respiratory paralysis. Very large doses paralyze the nerves.

**Treatment.** Give tannic acid followed by an emetic of mustard water; medicinal charcoal; stimulants; keep the extremities warm; make cold applications to the head; apply artificial respiration if necessary.

**Other Poisons.** Lobelia, lobeline, and tobacco call for the same treatment as for Nicotine.

**Nitrous Fumes.** See Nitrogen Oxides in Chapter 5.

Opium is found as a milky liquid in the unripe fruit of the opium poppy, *Papaver somniferum* L., or *P. album*, De. C. (Papaveraceae), which grows in Asia and Africa and is cultivated in the Balkan States, Hungary, and southern Russia. The liquid dries to a brown mass and has a characteristic odor.

About 25% of the drug is active material in the form of some twenty alkaloids, of which morphine (approximately 16%) is present in largest quantities. Opium is used chiefly as a source of these alkaloids.

Opium preparations include (1) the crude gum opium, containing between 10 and 16% of anhydrous morphine; (2) deodorized opium (morphine 10 to 10.5%), from which nauseating ingredients have been removed; (3) granulated opium (10 to 10.5% morphine) for preparing alcoholic solutions; and (4) powdered opium adjusted with inert sugar so that it contains 10 to 10.5% morphine.

Opium is used to produce sleep, relieve pain, and quiet nerves.

When administered by hypodermic its action is more rapid than when taken by ingestion.

The normal dose of opium containing 10 to 10.5% anhydrous morphine is 1 grain or 0.06 gm. The fatal dose varies, but in one who is not an addict it lies between 2 and 4 grains, the action being much faster in children than in adults.

*Identification.* Opium being largely morphine, carry out tests for morphine.

*Symptoms.* Drowsiness, nausea, desire to sleep, a loss of muscular power and sensitivity, pupils contracted to a pin point, deep stupor, and death resulting while in a coma.

*Treatment.* Have victim swallow a solution of 10 grains of potassium permanganate dissolved in a pint of warm water; repeat in about 30 minutes. Give an emetic each time to remove the permanganate. Keep the patient awake without excessive physical exercise, such as walking too much; apply artificial respiration if necessary. Apply ice to the head and heat to arms and legs, and give strong black coffee.

**Oxalic Acid.** See Acid, Oxalic.

Parathion  $[(C_2H_5O)_2PS \cdot OC_6H_4NO_2]$ , *O,O*-diethyl-*O-p*-nitrophenyl thiophosphate, is a phosphate ester insecticide. It is generally used in the form of sprays containing 3% or less and as dusts containing 4% or less. The phosphate esters exert their toxic action by inactivating acetylcholinesterase. It will exert its action through any portal of entry, that is, by being breathed in, by being absorbed through the skin, or by ingestion. In California in 1953, of 156 cases of poisoning attributable to phosphate esters, 128 were due to parathion and three of these died. There were four deaths in Oregon and California in 1954.

*Symptoms.* Headache, giddiness, blurred vision, weakness, nausea, cramps, diarrhea, discomfort in the chest, and anxiety. Other symptoms are sweating, abnormal contraction of the pupil, tearing, salivation, pulmonary edema, cyanosis, uncontrollable muscle twitches, convulsions, coma, and loss of reflexes and sphincter control.

*Treatment.* In the absence of symptoms, wash the stomach with tap water, if equipment is available, or give a quart of water or milk and induce vomiting by pharyngeal stimulation, followed by 1 oz. of sodium sulfate in 8 oz. of water as a cathartic.

If symptoms appear give atropine by means of syrets containing 2

milligrams, approximately 4 times the usual dose of 0.5 milligrams. Apply artificial respiration preferably by mechanical means, especially in the case of respiratory difficulty and convulsions, and supply oxygen.

*External Treatment.* Remove and discard all contaminated clothing. Wash the skin before symptoms appear or after they have been controlled by atropine with large volumes of water and soap. It will also be useful to wash the mucous membranes with water and soap.

Phenacetin ( $C_{10}H_{13}O_2N$ ), acetophenetidin, acetparaphenetidin, ethoxyacetanilid, *p*-acetphenetidine, or *p*-acetphenetidin is prepared as a white, odorless, somewhat bitter powder or crystalline scales by boiling paraphenetidin with glacial acetic acid.

Phenacetin is similar in its action to acetamide, being used to reduce mild fevers and for relief of nervousness, headache, and pain.

The normal dose is 5 grains or 0.3 gm., beginning with 3 grains for safety. The exact fatal dose is not positively determined, but 10 to 20 grains may kill a person with a weak heart, and 10 to 30 grains may prove fatal to a person with a normal heart. Death may linger for several days, or it may be sudden.

*Identification.* Phenacetin is excreted in urine as glucuronates or sulfates. (a) Conc. HCl, (b) aq. 5% sodium nitrite; (c) dil NaOH; (d) alkaline beta-naphthol. Boil the unknown with (a). Cool. Dilute with water. Add a few drops of (b) + (c) until litmus turns blue, then a few drops of (d). Red, turning mahogany on adding more (a), indicates acetanilid or phenacetin (azo-dye test).

*Symptoms.* Nausea and vomiting; cyanosis; slow, feeble pulse, subnormal temperature; mental sluggishness; stupor and collapse.

*Treatment.* Keep the patient warm and quiet, in a recumbent position. Apply external heat. Wash the stomach with an emetic of mustard or 30 to 60 grains zinc sulfate in water; give oxygen for cyanosis, and artificial respiration if necessary. Give aromatic spirits of ammonia if the patient is conscious.

*Other Poisons.* See *Other Poisons under Acetanilid.*

Phenol or Carbohc Acid ( $C_6H_5OH$ ), hydroxybenzene, oxybenzene, phenylhydroxide, phenic acid, or phenylic acid is a colorless to pinkish (on aging) solid, melting at  $109^\circ F.$ ; if it contains water or cresols it may become a sticky liquid on warm days. Phenol is manufactured in enormous tonnages for phenolic plastics by the action of sodium

hydroxide on benzene by alkaline hydrolysis of benzene monochloride at high pressures (chlorobenzene process, used in the United States for many years). It is the starting point for a great many organic syntheses, especially in the field of dyes; it is also an important laboratory reagent.

Liquid phenol is an 88 to 90% aqueous solution of phenol. Camphorated phenol contains 60% camphor, 30% phenol, and 3% liquid petrolatum, and is used as an antiseptic and local anesthetic.

Internally phenol has been used in diarrhea and as an injection for anthrax and tetanus; its use to check stomach fermentation is open to question. Externally it is used as an antiseptic on boils, venereal warts, and other growths; dilute solutions are used as a dressing for burns, stings, skin diseases, etc. It is sold, often mixed with chloride of lime, as a general disinfectant for toilets, drains, etc.

Phenol is not an acid, but exerts a powerful action and causes necrosis of the tissues with which it comes into contact. Although it is a most effective antiseptic, its terribly corrosive action on the tissues limits its use to applications where it will not come in contact with the skin in any strong concentrations. Wet dressings containing phenol are especially dangerous, particularly to infants, who absorb the poison rapidly. Since phenol has local anesthetic action, serious burns can occur before the patient is aware.

The normal dose is 1 grain or 0.06 gm. Eight to 15 gm. may be considered a fatal dose, although recovery has followed ingestion of more than 3 times this amount; and death from  $\frac{1}{10}$  the stated fatal dose.

*Identification.* Strong odor of phenol from breath or vomitus. **TEST 1.** (a) Dissolve 5 gm. mercury in 5 cc. fuming nitric acid. Dilute with 10 cc. water. After 24 hours pour off the clear upper liquid and use (Millon's reagent). Add few drops (a) to 1 cc. aq. unknown, and heat. Red indicates cresols and phenols. **TEST 2.** (b) Ether; (c) bromine water. Extract unknown with (b); add a few drops of (c). The white to yellowish precipitate of tribromophenol indicates phenol (Glaister's test). **TEST 3.** (d) Dilute neutral aq.  $\text{FeCl}_3$ . Add a few drops of (d) to 2 cc. of the unknown solution. Shake. Violet indicates phenols.

*Symptoms.* Burns, whitish in color, appear on the lips and mouth; pain in the throat and stomach; nausea and vomiting; headache, dizziness, drowsiness and depression, collapse; cold, moist skin; shallow

breathing, and cyanosis. If a large amount of carbolic acid has been taken, the patient becomes unconscious and dies in a few minutes from paralysis of the heart and respiration. The characteristic odor of phenol is present.

*Treatment. Do not give oils.* Administer the following as antidotes: an emetic followed by Epsom salts or Glauber's salts. Plenty of liquid should be given and the stomach should be washed out as rapidly as possible before the phenol has been absorbed. Use raw eggs and milk to protect the membranes. Keep the patient warm and quiet.

*External Treatment.* Wash with alcohol or whiskey; and then immediately, before the alcoholic solution has been absorbed into the tissues, flush it off with much water.

Phosphate Esters are a group of synthetic organic compounds used as insecticides. Some contain sulfur like Parathion, Systox, EPN, and Malathion. Others contain nitrogen like OMPA. Parathion and Malathion are discussed in this chapter. Systox is a water-soluble solid which is stable for over one month. It is the diethoxythiophosphoric acid ester of 2-ethylmercaptoethanol. OMPA is octamethyl pyrophosphoramidate. TEPP is a liquid, water-soluble compound that decomposes in about 6 hours. The symbol stands for tetraethyl pyrophosphate. TEPP, OMPA, Parathion, EPN, and Systox have all been implicated in poisonings and deaths. They cause their injury by inactivating acetylcholinesterase. See Parathion.

Phosphorus (P) is a nonmetallic element found in two common forms. One, the poisonous white or yellow phosphorus, found in the form of white, waxy, translucent cylinders, oxidizes rapidly in the air, giving off fumes of the oxide; it glows in the dark with a pale, yellow light, has the taste of garlic, and is usually kept under water. The other form of phosphorus is red, and is produced by heating yellow phosphorus in a closed vessel without air for 36 hours. Red phosphorus is not so toxic as white or yellow phosphorus; the red variety is also much less active chemically, is stable to light and air, and can be stored as a red powder without being covered with water.

*White or yellow phosphorus is used in fireworks, rat poisons, smoke screens, gas analysis, and manufacturing phosphoric acid.* Lucifer matches originally had heads of white phosphorus, sand, potassium chlorate, glue, etc., which were ignited by friction; but because of the poisonous nature of white phosphorus its use was prohibited by law,

and a compound  $P_4S_3$  mixed with potassium chlorate is used today. The safety match, on the other hand, contains a tip of potassium chlorate or lead oxide, or potassium dichromate, antimony trisulfide, powdered glass, and glue; these matches catch fire when rubbed against the igniter surface, on the box, which contains a mixture of red phosphorus, antimony trisulfide, and glue.

Suicidal cases involving phosphorus are prevalent, but phosphorus has been used also in homicide, as well as having been taken accidentally by children and alcoholics. White phosphorus inflicts severe burns. The fatal dose is difficult to determine, but 3 grains is regarded as lethal. Death occurs in 1 to 4 days.

*Identification.* White phosphorus catches fire when exposed to the air. Red phosphorus can be identified by burning a bit of it, dissolving the ash in water, and testing for orthophosphate as follows. (a) Aq. silver nitrate; (b) dil.  $HNO_3$ . To aq. unknown add 1 cc. (a) + 1 cc. (b). Yellow precipitate of  $Ag_3PO_4$  indicates that the original unknown was phosphorus.

*Symptoms.* Nausea and vomiting, garlic taste, thirst, pain in the throat and stomach, diarrhea, headache, weakness, and collapse. The vomitus is luminous in the dark.

*Treatment.* Give an emetic of mustard in water, or 3 grains of copper sulfate in water every 5 minutes until vomiting occurs, repeat emetic. Give whites of several eggs in water, and follow with a saline solution such as Epsom salts. Keep the victim warm and quiet. Avoid fats, oils, and milk.

*External Treatment.* Summon a physician. Use no oils or ointments. Apply a 2% copper sulfate solution to the burned area; this reacts with the phosphorus forming noncombustible copper phosphides of indefinite composition. Keep the burned area under water, or preferably under 2% copper sulfate solution until the particles of phosphorus can be removed. If copper sulfate is not available, wash with a baking soda solution (tablespoonful in a glass of water); keep it wet until a physician arrives.

**Picric Acid** [ $C_6H_2(NO_2)_3OH$ ], carbazotic, nitroxanthic, picronitric acid, T.N.P. or trinitrophenol, obtained by sulfonating phenol and treating the reaction mixture with nitric acid, forms yellow, odorless, very bitter crystals, which explode when heated ( $300^\circ C.$ ), detonated, or by percussion. For safety in transportation, 10-20% water is added.

Picric acid is used in matches and explosives, as a dye intermediate, and in the leather industry, and also in colored glass and electric batteries.

Medicinally, picric acid is used in ointments and dressings as an antiseptic for minor burns. Butesin picrate, a derivative, is applied as a 1% aqueous solution, or a 15% ointment.

Six grams has been taken without producing death.

*Identification.* The color of picric acid and butesin picrate will be deep yellow; they stain the skin yellow. (a) Aq. ammonium sulfide. Heat gently for 5 minutes the unknown water solution (*Care! Do not heat solid picric acid; it is explosive*) with 2 cc. (a) If within 5 minutes a red color of picramic acid develops, picric acid is indicated.

*Symptoms.* Mucous membranes and urine are deep yellow; the skin is irritated and deep yellow. Convulsions and collapse often occur following nausea and vomiting, the pulse is weak.

*Treatment.* Give the whites of several eggs, 1 tablespoonful of Epsom salts in a glass of water. Keep the victim warm and quiet.

Poison Ivy, Poison Oak, Poison Sumac. See Chapter 6.

Potassium Binoxalate ( $\text{KHC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ ), potassium acid oxalate, salt of sorrel, or sal acetosella is used for removing ink stains, cleaning wood, scouring metals; in photography; and as a mordant in the dyeing industry.

Fatal dose varies between 1 and 3 drams. Usually when more than 1 oz. is retained, death results regardless of proper treatment.

*Identification.* Same tests as for Acid, Oxalic.

*Symptoms.* Same as Acid, Oxalic.

*Treatment.* Avoid baking soda and other alkali carbonates or alkalies. Give milk of magnesia or chalk, with large quantities of water; follow with an emetic of mustard in water; repeat several times, follow with demulcent drinks of flour and water and the whites of several eggs. Use black coffee as a stimulant. Keep the patient warm and quiet.

Potassium Carbonate ( $\text{K}_2\text{CO}_3$ ), pearl ash, potash, salt of tartar, or salt of wormwood sold as white, hygroscopic, odorless granules or powder. Industrially it is used in the manufacture of soft soap and hard glass; in the textile and leather industries, and for manufacturing potassium compounds.

Because potassium carbonate is so irritating, it is not used inter-

nally; rather it is applied externally as a 15% ointment or a 1% aqueous solution.

The normal dose is 15 grains or 1.0 gm.; Potassium carbonate is an alkaline caustic, somewhat less powerful than potassium hydroxide.

*Identification.* Aq. solution turns litmus blue. **TEST 1.** Flame test, page 17. A purplish tint to the flame indicates potassium. Yellow only indicates sodium. **TEST 2.** (a) Dil. HCl; (b) limewater; (c) a small glass tube, the size of a pencil. Treat the solid unknown with 1 cc. (a). A fizzing gas is probably  $\text{CO}_2$ . Hold a drop of (b) in a small tube just suspended above the fizzing substance. Limewater (b) turns milky and indicates carbonate.

*Symptoms.* Almost immediately there is pain in the mouth, throat, and stomach; nausea and vomiting; pallor; weak pulse and collapse. Usually death occurs within 24 hours.

*Treatment.* Give harmless acids such as diluted vinegar, lemon juice, citric, or tartaric acid. Give freely. Empty the stomach with an emetic if the solution is not too strong. Give demulcent drinks and raw eggs. Apply external heat. Keep the victim warm and quiet.

*External Treatment.* Wash thoroughly with water, then with lemon juice or vinegar and again with water.

Potassium Chlorate ( $\text{KClO}_3$ ) is manufactured by the electrolysis of a warm aqueous solution of potassium chloride, the products being allowed to mix. The same reaction occurs if chlorine is led into a warm solution of potassium hydroxide. Potassium chlorate crystallizes from solution on cooling. It is found as crystalline powder, granules, and in drug stores as tablets; and its active oxidizing action makes it useful in matches, fireworks, explosives, and the printing and dyeing of cotton and wool black.

Potassium chlorate is used only externally, usually in a 3 to 5% solution as mouthwash or gargle for gingivitis and other throat disorders, but this use is waning.

Poisoning usually results when a potassium chlorate gargle is swallowed by mistake. The injury is to the kidneys and blood. The normal dose is 5 grains or 0.3 gm. The fatal dose for an adult varies from 8 to 60 gm.

*Identification.* To a dialyzed solution of the stomach contents, add a little indigo sulfate and acidulate with dilute sulfuric acid. If chlorate is present, the addition of sulfurous acid will discharge color. Aniline sulfate with sulfuric acid plus chlorate gives a blue color.



*Symptoms.* Pains in the abdomen, nausea and vomiting, diarrhea, jaundice, pallor, cyanosis, coma, and collapse.

*Treatment.* Give no stimulants. Wash out the stomach with an emetic, followed by demulcent drinks—flour in water, oatmeal gruel. Keep warm, apply external heat. When the physician arrives he may relieve the condition by removing some of the blood from a vein and replacing it intravenously with normal salt solution.

*Other Poisons.* Bromates, nitrates, and other chlorates call for the same treatment as for Potassium Chlorate.

Potassium Hydroxide (KOH), caustic potash, or potassa, sometimes (incorrectly) called potassium hydrate, is a powerful alkali similar to sodium hydroxide. Both are sold as white or slightly yellow lumps, rods, pellets, granules, or flakes, which absorb moisture from the air very rapidly, becoming damp. Potassium hydroxide has a multitude of uses in industry—in making soft and liquid soaps, for absorbing carbon dioxide from coke ovens, as a paint and varnish remover, in the printing trades, etc.

Potassium hydroxide has been used externally for cauterizing bites from rabid animals. A special paste containing equal parts of lime-water and potassium hydroxide is available for cauterizing and destroying surface growths.

An aqueous solution of potassium hydroxide is extremely caustic to human tissues. There have been a few cases of homicidal poisoning, but the majority are suicidal or accidental. Forty grains may cause death of an adult.

*Identification.* Solid potassium hydroxide if exposed to the air becomes very damp. Aq. KOH turns litmus blue, has a soapy feeling (wash hands immediately, do not wipe on clothing). Flame test, page 17. Yellow flame indicates sodium. Purplish flame indicates potassium.

*Symptoms.* Severe pains in the throat, mouth, and stomach; nausea and vomiting; pallor, slow, weak pulse, burns on the lips and mouth. The victim often dies from suffocation as a result of the swelling of the air passages.

*Treatment.* Give harmless acids such as diluted vinegar, lemon juice, citric or tartaric acid. Give freely the whites of eggs. Care must be taken if a stomach tube is to be used to empty the stomach, as it may puncture the weakened walls of the stomach. Give olive oil or heavy milk drinks; apply external heat. Keep quiet and warm.

*External Treatment.* Summon a physician. Wash thoroughly with water, then with lemon juice or vinegar, and again with water.

Potassium Permanganate ( $\text{KMnO}_4$ ) or chameleon mineral is a deep purple, odorless, crystalline salt, manufactured by passing ozone into an aqueous solution of potassium manganate. Potassium permanganate is a powerful oxidizing agent used for bleaching fabrics, resins, fats and oils; for darkening leather and wood; and in analytical chemistry.

The effectiveness of potassium permanganate against snake bites is questioned by some authorities. It is taken internally to counteract poisoning by alkaloids, phosphorus, and cyanides. Externally a 0.5% solution is used as a wash for a number of ills: ulcers, abscesses, mouth diseases, etc.

Potassium permanganate can damage the membranes; also, the victim may die from collapse at any time after ingestion of a quantity that does not have to be very large. The normal dose is 1 grain or 0.06 gm.

*Identification.* Potassium permanganate solutions are deep purple. (a) Dil.  $\text{H}_2\text{SO}_4$ ; (b) 3% hydrogen peroxide (household). Dilute a crystal of the unknown until the solution is faint pink. To 2 cc. of this add 1 cc. (a); then add (b) up to 10 cc. A purple solution becoming colorless  $\text{MnSO}_4$  indicates permanganate.

*Symptoms.* Nausea and vomiting; rapid, weak pulse; pallor; cold, clammy skin; and collapse.

*Treatment.* Empty the stomach with an emetic; give the whites of eggs, and follow with one tablespoonful of medicinal charcoal and water; keep quiet and apply external heat. When the physician arrives, he may administer stimulants.

Quaternary Ammonium Compounds are organic compounds in which the four hydrogens of ammonium ion are replaced by organic radicals. These substances, which are also known as Cationic Detergents, are widely used because they have germicidal action as well as detergent action. Among the more common of these compounds are the alkylbenzyltrimethylammonium chlorides which are sold under trademarks such as Roccal, Zephiran, Onyx BTC, etc.; but there are many others sold under a host of names. These substances are readily absorbed and interfere with various cellular functions. A number of fatalities have occurred from their ingestion. The lethal dose is esti-

mated as being in the range of 1 to 3 gm. Soaps and the body tissues inactivate such compounds.

*Symptoms.* The main symptoms are nausea, vomiting, collapse, and coma; but convulsions may also occur. Death can result in from one to four hours.

*Treatment.* Give tap water and induce vomiting or use gastric lavage, if possible. Give a cathartic. Soap will serve as an antidote for the unabsorbed cationic detergent.

*Sewer Gas.* See Chapter 5.

*Silver Nitrate* ( $\text{AgNO}_3$ ) or lunar caustic, obtained by treating free silver with dilute nitric acid, forms colorless, odorless, transparent flaky crystals, which darken in the light. The commercial product is almost 100% pure and is the one usually employed medicinally. Silver nitrate is used in the manufacture of other silver salts; in photography; for resilvering mirrors, in indelible inks and in hair dye; and as a reagent in analytical chemistry.

Silver nitrate pills are taken internally for stomach ulcers and intestinal disorders. Externally an extremely dilute solution is used for a variety of germicidal and antiseptic purposes, and also to cauterize animal bites and as an astringent.

Many of the poisoning cases are largely due to absorption of silver nitrate in the blood, followed by deposition in the various tissues of the body. The normal dose is  $\frac{1}{8}$  grain or 0.01 gm. Thirty grains has proved fatal to an adult. Death occurs in a few hours to days.

*Identification.* TEST 1. See spot tests, page 17. TEST 2. (a) Dil. HCl. (b) dil.  $\text{HNO}_3$ ; (c) dil.  $\text{NH}_4\text{OH}$ . Treat the unknown solution with a few drops of (a) + a few drops of (b). The white precipitate of AgCl (silver chloride), dissolving in (c) to form soluble  $\text{Ag}(\text{NH}_3)_2\text{Cl}$  diamine silver chloride, indicates silver. TEST 3. (d) Conc.  $\text{H}_2\text{SO}_4$ . Add 1 cc. (d) to solid unknown. Brown fumes of  $\text{NO}_2$  indicate nitrate.

*Symptoms.* Pain in the throat and stomach; nausea and vomiting of black colored material; pallor, weak pulse; the lips may first have a grayish-white color, then black; coma and collapse.

*Treatment.* Give large amounts of common table salt in water, followed by an emetic of mustard in water; give demulcent drinks; apply external heat. Keep quiet and warm.

*Silver Salts.* *Identification.* Test for silver as under Silver Nitrate. Test for cyanide as follows. (Note that treatment is different if cyanide

is found present.) (a) Aq. 3% cupric acetate; (b) glacial acetic acid saturated with benzidine. Dip filter paper in a mixture of 15 cc. water + 1 cc. (a) + 5 cc. (b) and dry. Paper is dipped into the moistened unknown and indicates cyanide if it turns blue.

*Symptoms and Treatment.* Same as for silver nitrate, except for silver cyanide. For silver cyanide the treatment is as follows: Summon a physician. Have patient swallow 1 tablespoonful of hydrogen peroxide (3%, household variety); use stimulants such as aromatic spirits of ammonia in water; have patient inhale ammonia; give artificial respiration if necessary.

*Smokes.* See Chapter 5.

*Snake Venom.* See Chapter 6.

**Sodium Carbonate** ( $\text{Na}_2\text{CO}_3$ ), sal soda, Scotch soda, soda ash, soda crystals, washing soda, white acid, or trona (some of these names applying to the crude, natural products) is similar to potassium carbonate in uses, symptoms, and treatment. The average dose of the monohydrate ( $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ ) is only 4 grains or 0.25 gm.

*Identification.* Same tests as for Potassium Carbonate, except that the flame test for sodium is yellow.

*Symptoms and Treatment.* Same as for Potassium Carbonate.

**Sodium Fluoride** ( $\text{NaF}$ ), obtained by the reaction of sodium carbonate on hydrofluoric acid, forms colorless crystals and white powder. The common grade contains 1.5 to 3% sodium silicofluoride ( $\text{Na}_2\text{SiF}_6$ ), and 94 to 97%  $\text{NaF}$ . It is used as an insecticide for roaches, fleas, ants, lice, etc., and also for preserving wood and in mucilages and pastes. Sodium silicofluoride, Salufer, or sodium fluosilicate is similarly employed, and also in moth-proofing and in ceramic finishes.

Sodium fluoride is a deadly poison. Death has been caused by less than 1 grain. Some states and cities like the City of New York require that sodium fluoride and other fluorides used as insecticides must be colored Nile Blue or Microcline Green so that the powder will not be mistaken for a breeding powder.

*Identification.* TEST 1. Flame test, page 17. A yellow flame indicates sodium. TEST 2. Test for fluoride as described under Acid, Hydrofluoric.

*Symptoms.* Burning cramplike pains in the abdomen, muscular twitching at times, grayish-blue skin, pallor, weak pulse, convulsions.

*Treatment.* Give large amounts of water followed by limewater,

chalk, or weak calcium chloride solution; administer oxygen, apply artificial respiration if necessary. Keep quiet and warm.

*External Treatment.* Wash with water and apply a paste of baking soda, milk of magnesia, or chalk and water.

Sodium Fluoroacetate ( $\text{FCH}_2\text{COONa}$ ), 1080, is a colorless, odorless, water-soluble salt which in extremely dilute solution has a vinegar-like taste. When used as a rodenticide, the salt is dissolved in water in the proportion of 12 gm. per gallon, approximately 1 part in 300, and is placed in squat soufflé cups, each containing about  $\frac{3}{4}$  oz. As a safety measure, such solutions should be colored black with a 5% solution of a purified nigrosine black dye. Sodium fluoroacetate is also mixed with the usual rat baits in the ratio of 1 oz. of the pesticide to 28 pounds of bait, that is, a ratio of 1 to 500.

Sodium fluoroacetate is extremely poisonous to human beings, the fatal and near fatal dose being in the range of 0.06 to 0.3 gm. for a 150-pound man. Its toxicity probably results from its interference with the acetate metabolism.

*Symptoms.* In some 13 fatal cases, 5 suspected deaths, and 6 non-fatal cases, the symptoms appeared after 30 minutes and within about 2 hours. At first there was nausea and vomiting with mental apprehension followed by epileptiform convulsions, uneven heart beat and respiration, exhaustion, coma, and, in the fatal cases, death.

*Treatment.* Since there is relatively little experience with this poison, the recommended treatment can only be tentative. Wash the stomach with tap water. This treatment may be of some help even several hours after the ingestion of this rodenticide. Give orally 4 cc. per kilogram of body weight (about 3 oz. for a child and about 9 oz. for an adult) of an equal mixture of 50% ethyl alcohol (whiskey) and 5% acetic acid, that is, vinegar, or either one alone if both are not available. Repeat in 3 or 4 hours, if necessary; or smaller amounts may be given at shorter intervals.

If gastric lavage cannot be performed in short order, give about 1 quart of water or milk and induce vomiting without an emetic. Repeat at least one time and then give 1 oz. of sodium sulfate in 8 oz. of water as a cathartic.

If glyceryl monoacetate (monoacetin) is available it may be substituted for the alcohol-and-vinegar mixture by a physician, both intramuscular and intravenous routes being suggested.

**Sodium Hydroxide** ( $\text{NaOH}$ ), caustic soda, or lye, incorrectly called sodium hydrate, is sold as white, hygroscopic, odorless sticks, pellets, flakes, powder, granules, or lumps. It is manufactured by the electrolysis of molten rock salt or brine residue. Sodium hydroxide is a powerful alkali, and as such will "sweeten gasoline," that is, neutralize gum-forming acids; as an alkali, too, it reacts with fats to form soaps and emulsifies grease in sinks and toilet bowls, for which purpose it is sold as a household cleanser (lye). Other uses of this most important alkali are in converting cellulose to alkali cellulose, the first step in making rayon; in the paper-pulp industry; and in the textile and rubber industries.

This caustic has been taken both by accident and as a means of committing suicide. In a few instances it has been used to disfigure and mutilate the body to make identification difficult. Thirty grains may cause death.

*Identification.* Same tests as described for Potassium Hydroxide, except that the flame test for sodium is yellow.

*Symptoms.* Sodium hydroxide produces symptoms almost immediately: severe pains in the throat, mouth, and stomach; bloody vomitus; weak, rapid pulse; pallor; cold, clammy skin; collapse. The victim often dies as a result of suffocation from the swelling of the passages, or as a result of shock; usually within 24 hours.

*Treatment.* Give large amounts of harmless acids such as diluted vinegar, lemon juice, citric or tartaric acid, as well as raw eggs and milk or other demulcent drinks. Keep the patient warm and quiet and apply external heat. If the solution is not too strong, the stomach may be emptied with a stomach tube by a physician; but care must be exercised, since the tube may penetrate the weakened walls of the stomach.

*External Treatment.* Wash with water, then with lemon juice or vinegar, and again with water. If in the eyes, wash with 5% boric acid solution.

**Sodium Nitrite** ( $\text{NaNO}_2$ ) is a white, odorless, crystalline salt obtained by heating sodium nitrite or by treating an alkali with oxides of nitrogen. It is used industrially for manufacturing the diazo dyes, in the food industry for the curing of meats and fish, and as an analytical reagent.

Medicinally it is used internally for heart trouble, migraine, and epilepsy.

**Identification.** TEST 1. Flame test, page 17. A yellow flame indicates sodium. TEST 2. (a) Dil  $\text{H}_2\text{SO}_4$ , (b) conc.  $\text{H}_2\text{SO}_4$ . The solid unknown is treated with 1 cc. (a). Another solid portion is treated with 1 cc. (b). Brown fumes of  $\text{NO}_2$  with either (a) or (b) indicate nitrite. Brown fumes with (b) but not with (a) indicate nitrate. TEST 3. (For other nitrites) Nitrites are found in the urine. (c) Aq. resorcinol; (d) conc.  $\text{HCl}$ . (e) dil.  $\text{NH}_4\text{OH}$ . Unknown + 1 cc. (c) + 1 cc. (d). Boil. Red, changed to violet by a slight excess of (e) (*Care! Add drop by drop, while shaking.*) indicates nitrite.

**Symptoms.** (Note that this is *nitrite*, for *nitrate* symptoms see Potassium Chlorate.) Flushed face, violent then lessened heart action, dizziness and throbbing headache, muscular tremors, disturbed vision, nausea and vomiting, but rarely convulsions. Death occurs from respiratory failure or sometimes from heart failure. Sodium nitrite causes the formation of a large amount of methemoglobin, this dilates the blood vessels causing a drop in blood pressure.

**Treatment.** (Note that this is *nitrite*; for *nitrate* treatment see Potassium Chlorate.) Fresh air, recumbent position; give an emetic of mustard and water and repeat several times; give large quantities of black coffee; apply artificial respiration if necessary. Keep the patient warm and quiet.

**Other Poisons.** The same treatment as for Sodium Nitrite is used for other nitrites and nitro-compounds (nitroglycerin, trinitrotoluene). Nitrocellulose is actually cellulose trinitrate.

**Spider Poisons.** See page 198.

**Strychnine** ( $\text{C}_{21}\text{H}_{22}\text{O}_2\text{N}_2$ ) or *nux vomica* is obtained from plants of the genus *Strychnos* and from the seed of *nux-vomica*. It is a highly poisonous alkaloid; its soluble salts are bitter. It is found as crystals and powder. In addition to being used in medicine, it is also an active ingredient in poisons for rats, mice, and other rodents and for fur-bearing animals.

Cases of strychnine poisoning are common, most of them being suicidal and a few homicidal. It is taken either by mouth or hypodermically. This drug produces its chief action on the nervous system. The normal dose of the sulfate is  $\frac{1}{30}$  grain or .002 gm. One quarter grain of strychnine sulfate has produced death; on the other hand recovery has followed after 20 grains had been taken.

**Identification.** TEST 1. (a) 1% ammonium vanadate in conc.

$\text{H}_2\text{SO}_4$ ; (b) dil. ammonium hydroxide. Add 2 drops of (a) to the unknown solution. Blue changing to brilliant violet indicates strychnine. To this add (b); changes to brilliant reddish violet indicate strychnine (Mandelin's test). **TEST 2.** (c) Chloroform; (d) conc.  $\text{H}_2\text{SO}_4$ ; (e) a crystal of potassium dichromate. Dissolve the unknown residue in (d). Drop a crystal into the mixture; shake gently. Colored streamers of blue, violet, red, and orange playing around crystal indicate strychnine. **TEST 3.** (f) Solid manganese dioxide. Unknown + pinch of (f) + 1 cc. (d). Violet indicates strychnine.

**Symptoms.** The symptoms usually occur about 10 or 15 minutes after the poison has been ingested, but they may occur immediately or after a delay of an hour. There is a sense of tightness in the chest, a shuddering, and then a violent spasm, characterized by stiffness of the neck, extension of the legs, a sardonic grin, staring eyes, and stiffened muscles of respiration; cyanosis; weak, rapid pulse; and dilated pupils.

**Treatment.** Do not give emetics or use the stomach tube, as any effort to empty the stomach is likely to cause a fatal convulsion. Give 10 grains of potassium permanganate in a glass of water or 1 tablespoonful of medicinal charcoal. Have victim inhale amyl nitrite for collapse. Apply artificial respiration if necessary. If convulsions are violent, attempt to control them by administering inhalations of chloroform or ether. Give strong tea to relieve thirst. Keep the patient quiet and warm.

**Other Poisons.** Brucine, ignatia, nux vomica, tincture nux vomica, and picrotoxin call for the same treatment as for Strychnine.

Sulfanilamide ( $\text{NH}_2 \cdot \text{C}_6\text{H}_4 \cdot \text{SO}_2 \cdot \text{NH}_2$ ) and other sulfa drugs, white crystalline powders used against specific infections, should be taken *only under a physician's direction*, improperly administered, they irreparably damage the kidneys and destroy red blood corpuscles. Normal oral doses are (a) for sulfanilamide, 1 gm. daily in divided doses for each 20 pounds of body weight up to 100 pounds; (b) for sulfapyridine, 2 gm. initially, followed by  $\frac{1}{2}$  to 1 gm. doses every 2 to 4 hours, total dose 15 to 25 gm.; (c) for sulfathiazole, 4 gm. initially, then 1 gm. every 4 hours until temperature is normal for 72 hours. A child's dose is proportionately smaller.

**Symptoms.** Weakness, pallor, nausea, vomiting, weak pulse.

**Treatment.** Immediately stop use of the drug and summon a physician. Keep the victim warm and quiet.



Thallium Sulfate, found in rat poisons and insecticides, gives a green flame test. Less than  $\frac{1}{2}$  gm. is fatal.

*Symptoms* are usually first noticed 24 hours after the poison is taken. Severe abdominal pain and vomiting; muscular weakness; a purplish line on the gums; breath foul; salivation; falling out of hair after a few days; perhaps swelling of the cheeks and eyelids. The cause of death is usually respiratory failure.

*Treatment.* Give an emetic of mustard in water; demulcents; give stimulants of hot coffee; apply artificial respiration if necessary, and oxygen for cyanosis; keep the body warm.

Thiocyanate insecticides are a group of synthetic organic insecticides which have in common the radical SCN. Lethane-384 is  $C_4H_9OCH_2CH_2OCH_2CH_2SCN$ ; lauryl thiocyanate is  $C_{12}H_{25}SCN$ ; there is a group of the beta-thiocyanoethyl esters of the  $C_{10}$  to  $C_{18}$  aliphatic acids,  $C_{17}H_{35}$  to  $C_9H_{19}-COOCH_2CH_2SCN$ ; and Thanite or isobornyl thiocyanacetate,  $C_{10}H_{17}OOCCH_2SCN$ . The toxicity of these insecticides is less than that of nicotine. A number of deaths have occurred from the ingestion of such materials. For instance, the ingestion of 5 gm. of Lethane-384 and 14 gm. of lauryl thiocyanate have proved to be fatal.

*Symptoms.* Characteristic are respiratory difficulty and convulsions.

*Treatment.* Give as much as 1 quart of water or milk and induce vomiting by tickling the throat behind the roof of the mouth. Give 1 oz. of sodium sulfate in 1 cup of water as a cathartic. Use artificial respiration in spite of respiratory difficulty or convulsions. If a stomach tube is available, wash the stomach thoroughly with water.

*External Treatment.* Scrub the contaminated skin with soap and water and rinse thoroughly.

Toxaphene or chlorinated camphene is a mixture of chlorinated hydrocarbons having an empirical formula approximating  $C_{10}H_{10}Cl_8$ . It is used as an insecticide and is marketed as a 40% dust concentrate, as dilute dusts, and as a wettable powder; as impregnated pellets; as a 42 to 73% emulsifiable concentrate; and in other forms. Harmful and sometimes fatal amounts of toxaphene can enter the body through the mouth, the respiratory system, and the skin. The absorption of the insecticide is promoted by the presence of oils and fats in the intestine. The acute lethal dose for man is in the range of 2 to 7 gm.

*Symptoms.* Convulsions may occur without any prior symptoms al-

though nausea and vomiting may first occur. If the poisoning is not fatal, the convulsions are followed by weakness, lassitude, and amnesia.

*Treatment.* See DDT.

**Turpentine** ( $C_{10}H_{16}$ ), resinous hydrocarbons from pine trees, is used in paints, polishes, etc. One teaspoonful has killed a child; 6 oz. killed an adult. Maximum allowable working concentration is 100 ppm.

*Identification.* Odor on breath, clothing, vomitus. Mix 2 cc. of the unknown + 2 cc. ethyl alcohol + 1 cc. 1% vanillin in HCl. Shake. Pink turning blue-green from heat indicates turpentine.

*Symptoms.* Reddened skin; burning sensation in the mouth; vomiting, colic, diarrhea, symptoms of shock.

*Treatment.* Give mustard emetic, Epsom salts with much water, demulcents; heat the body and give black coffee as a stimulant.

**Warfarin** [ $C_9H_5O_3 \cdot CH(CH_2COCH_3) \cdot C_6H_5$ ], 3-(alpha-acetonylbenzyl)-4-hydroxycoumarin, is a rodenticide of the anticoagulant type. It is commercially available in the form of a 0.5% powder, the diluent generally being cornstarch. It is put up with an additional bait such as corn meal, bread crumbs, or meat and the final concentration is adjusted to 0.025% or less.

Warfarin is readily absorbed through the intestinal tract. It causes hemorrhages by inhibiting prothrombin formation and capillary damage. It is most effective in repeated small doses.

*Symptoms.* Serious illness was caused by the eating of 1.7 milligrams of warfarin per kilogram of body weight per day for 6 consecutive days—that is, eating almost 1 pound of warfarin bait per day for 6 days. The symptoms are hemorrhagic, such as nosebleeds, large bruises at joints such as elbows and knees, paleness, and blood in urine and stools.

*Treatment.* Gastric lavage with tap water, followed by 30 gm. of sodium sulfate in 1 cup of water as a cathartic. Give vitamin K, 50 to 100 milligrams three times daily.

**White Lead** [ $Pb_3(OH)_2(CO_3)_2$ ], basic lead carbonate, ceruse, cerussa, flake lead, lead subcarbonate, or magistery of lead (sometimes incorrectly called lead carbonate) is made by the slow action of fermentation gases (acetic acid, water, and carbon dioxide) on buckles of lead (Dutch process, which has been in operation 300 years); it is also manufactured by the action of carbon dioxide on lead spray in the

presence of acetic acid (Carter process) and superheated steam. White lead, a thick, creamy, heavy substance is used extensively in paints, putty, and cements.

White lead is used 10 to 30% in an ointment for skin diseases.

The fatal dose of white lead is 25 gm.

*Identification.* TEST 1. See spot tests, page 17. TEST 2. (a) Dil. HCl. Apply the test for carbonate described under Potassium Carbonate. TEST 3. Apply tests given under Lead.

*Symptoms.* A metallic taste in the mouth; throat dry and constricted; nausea and vomiting, diarrhea; leg and stomach cramps; a blue or black line on the gums. Anemia and paralysis may occur.

*Treatment.* Give 2 tablespoonfuls in  $\frac{1}{2}$  glass of water of Epsom salts (magnesium sulfate) or Glauber's salt (sodium sulfate). Follow with an emetic of mustard in water. Keep the patient warm with blankets and apply external heat. Give demulcent drinks, and stimulant. Give plenty of milk. For mild poisoning the patient should drink several quarts of milk.

Zinc (Zn) is a bluish-white, lustrous metal. It is found in the form of ingots, lumps, shot, sticks, granules, and powder. Some of its salts, such as the following, are poisonous.

ZINC ACETATE, is used to preserve wood, as a mordant in dyes, as a reagent, and in the manufacture of glazes for painting on porcelain. In medicine zinc acetate is used chiefly externally as an antiseptic, as a mouth spray and wash; and as an astringent. Injections of it are given in certain venereal diseases

ZINC CHLORIDE, besides its use in medicine, finds very wide use in embalming materials, in solutions for preserving wood, in flux, etching, fire-proofing lumber, paper manufacture, deodorants, and disinfectants.

ZINC SULFATE, is used in medicines, as a mordant in calico dyeing, for preserving wood and skins, bleaching paper, and as a reagent in chemistry.

Other medically important zinc salts include ZINC BROMIDE, used in epilepsy; ZINC CARBONATE, used pure or 20% in ointment as a mild astringent and protection on inflamed surfaces, ZINC OXIDE, 5 to 20% in ointments for burns, and as a dusting powder; and ZINC STEARATE, a soft white powder used in dusting powders for infants to prevent chafing.

Zinc salts have been swallowed accidentally, as well as with the

intent to commit suicide. One and one-half ounces of zinc sulfate may be considered a fatal dose; 6 gm. of zinc chloride has caused death.

*Identification.* See spot tests, page 17.

*Symptoms.* The victim will have a metallic taste, pain in the stomach, excessive salivation, vomitus of bloody material, purging, and collapse. Death may occur in a few hours, or within a few days.

*Treatment.* Give medicinal charcoal (1 tablespoonful in water) or whites of eggs. Follow with sodium bicarbonate (1 tablespoonful in water). Give water freely, keep the patient quiet and warm until the arrival of a physician.

*Other Poisons.* Cadmium salts call for the same treatment as for Zinc salts.

Zinc Phosphide ( $Zn_3P_2$ ) was first used about 1929 as an insecticide and in 1936 was employed as a rodenticide. It is a crystalline gray powder occurring in commercial preparations as a dull black material. It is insoluble in water and though stable when dry, slowly hydrolyzes in the presence of moisture, liberating phosphine. It is made by pouring molten zinc on red phosphorus.

A number of accidental deaths have occurred from the ingestion of zinc phosphide. It is less toxic to rats than 1080 (sodium fluoroacetate), ANTU, and thallium sulfate, but is much more toxic than arsenic trioxide, fortified red squill, and barium carbonate.

*Symptoms.* Difficulty in breathing, nausea and vomiting, stomach pains and diarrhea, slow action of the heart, circulatory collapse, and death.

*Treatment.* The toxic action may be minimized by immediate ingestion of weak alkali followed by washing of the stomach with 5% sodium bicarbonate solution.

## 4

# EMERGENCY INFORMATION FOR IMMEDIATE REFERENCE

**REMEMBER:** *Call a physician immediately. Get in touch with your Poisoning Information Center.*

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Acetanilid</b> Used to relieve neuralgia and muscular pains, reduce fevers, and in the manufacture of other medicinals.	Nausea and vomiting, slow, feeble pulse, subnormal temperature, mental sluggishness, cyanosis; stupor and collapse	Give an emetic of Epsom salts and water; repeat several times. Keep the victim warm and quiet, give a stimulant like tea or coffee, apply artificial respiration if necessary, and administer oxygen if available.
<b>Acid, Acetic</b> Used to make acetates, acetate plastics, acetate rayon, and as a solvent.	Skin is yellow where it comes in contact with the acid, burns on the lips and mouth; pain in the throat and stomach, difficulty in swallowing; nausea and vomiting; feeble pulse; diarrhea and collapse.	Avoid stomach tube, emetics, or carbonates if the acid taken was concentrated. Give milk of magnesia and quantities of water or milk, follow with whites of eggs and milk. Keep the victim warm and quiet.
<b>Acid, Boric</b> Used as eyewash, and in external ointments.	Nausea, diarrhea, headache, cold sweat, subnormal temperature, rash, collapse.	Eliminate its use. Avoid baking soda. Give hot milk, emetic. Keep patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
Acid, Carbolic	Same as Phenol	Same as Phenol
Acid, Hydrochloric Used extensively in industry and in the laboratory.	The lips and mouth on contact with the acid are usually white at first, but later turn brown. Pain in the throat and stomach; difficulty in swallowing; nausea and vomiting, feeble pulse, diarrhea and collapse.	Avoid stomach tube, emetics, or carbonates if the acid taken was concentrated. Give milk of magnesia and quantities of water or milk, follow with whites of eggs and milk. Keep the victim warm and quiet.
Acid, Hydrocyanic Gas used as a fumigant for citrus trees, and in ships and buildings against rodents and vermin; salts used for case hardening steel.	Possesses a peculiar peach blossom odor. Nausea and vomiting, feeble pulse, shallow breathing, dyspnea; cyanosis, convulsions and collapse	The treatment must be prompt. Have the victim inhale amyl nitrite for about 20 seconds. Give 2 tablespoonfuls of hydrogen peroxide and quantities of water, and repeat until the vomitus contains no odor of hydrocyanic acid. Apply artificial respiration if necessary. Keep the victim warm and quiet.
Acid, Hydrofluoric Gas or liquid used for etching glass, also used in the manufacture of fluorides.	Same as Acid, Acetic	The treatment must be prompt. Give weak solutions of limewater, followed with warm water, repeat several times. Give a stimulant and apply artificial respiration if necessary. Keep the victim warm and quiet.
Acid, Nitric Used extensively as a nitrating agent in making explosives and fertilizers, also used as an oxidizing agent.	Stains on the lips and mouth are first white, later turning to a deep yellow. Other symptoms same as Acid, Acetic	Same as Acid, Acetic
Acid, Oxalic Used as an industrial bleach; and as an oxidation reduction standard in the laboratory.	Same as Acid, Acetic	Same as Acid, Acetic

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Acid, Phosphoric</b> Used in the manufacture of many phosphates, also, in the engraving and lithography trades.	Same as Acid, Acetic	Same as Acid, Acetic
<b>Acid, Sulfuric</b> The most widely used acid in all of chemical industry	Same as Acid, Acetic	Same as Acid, Acetic
<b>Aconite [and Aconitine]</b> A source of alkaloids and one of the most deadly drugs known. Used to relieve pain locally, to lower blood pressure, and to reduce fever.	Salivation, a tingling sensation on the lips, mouth, and in the throat, nausea and vomiting, followed by collapse	Treat promptly; avoid emetics. Place the victim on his back with the feet elevated, give 10 to 30 grains tannic acid in water and follow with powdered charcoal, potassium permanganate (4 grains) in water. Apply cold to head, heat to body, artificial respiration and oxygen if necessary.
<b>Alcohol, Ethyl (Grain Alcohol)</b> Used in beverages, medicines, extracts, etc.	The effects vary: some patients become quarrelsome, some sentimental others fall asleep. Nausea and vomiting the patient enters a stage of depression.	Give an emetic of mustard and water, apply cold applications to the head, give a stimulant like tea or coffee. Keep the patient warm and quiet.
<b>Alcohol, Isopropyl</b> A substitute for rubbing alcohol	Same as Alcohol, Ethyl	Same as Alcohol, Ethyl
<b>Alcohol, Methyl (Wood Alcohol)</b> Used as solvent for shellacs and resins, in the manufacture of dyes and varnishes as an antifreeze, a fuel, etc.	Initial symptoms like those of ethyl alcohol. Later, nausea and vomiting, dizziness, headache, dilated pupils, delirium, blindness.	Give an emetic of mustard and water, repeat several times, follow with Epsom salts and stimulant. Keep the patient warm and quiet.
<b>Aminopyrine</b> Used to relieve headache, neuralgic pains, lower temperature in fever.	Same as Acetanilid	Same as Acetanilid

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Ammonium Hydroxide</b> (Ammonia Water) Used in cleaning and bleaching, removing stains; has a wide variety of uses about the home.	Burns on the lips and mouth, severe pains in the throat and stomach, diarrhea, weak pulse, pallor, and collapse.	Give lemon or grapefruit juice, or vinegar; whites of eggs and milk. Keep the victim warm and quiet.
<b>Antimony Trichloride</b> Used in medicine, in the manufacture of alloys, fireworks, etc.	Metallic taste in the mouth, pains in the abdomen, nausea and vomiting, the vomitus is blood stained, spasms of the fingers, arms and legs, followed by collapse.	Give tannic acid or strong tea; give an emetic of mustard and water, repeat several times follow with egg whites. Keep the patient warm and quiet.
<b>Antimony Potassium Tartrate</b> Used as an emetic and expectorant.	Overdose causes symptoms similar to Antimony Trichloride	Same as Antimony Trichloride
<b>Antipyrine</b> Uses are similar to those of Acetanilid.	Same as Acetanilid	Same as Acetanilid
<b>ANTU</b> Used as a rodenticide.	Sharp drop in temperature and pulmonary edema.	Induce vomiting by tickling the throat well behind the roof of the mouth or by giving an emetic such as salt water. Keep the victim warm and quiet.
<b>Apomorphine</b> Used as a cardiac depressant, emetic, sedative, and hypnotic.	Nausea and vomiting, pallor, flow of tears, exhaustion, and collapse.	Allow the victim to inhale ammonia fumes, give an emetic of mustard and water, and a stimulant; apply ice to head, apply artificial respiration if necessary. Keep victim warm.
<b>Arnica</b> Used as a counterirritant in sore muscles, bruises, sprains and strains.	Pain in the throat and stomach, nausea and vomiting, pallor, weak pulse, subnormal temperature.	Give an emetic of mustard and water, or medicinal charcoal, and repeat several times follow with the whites of several eggs and milk; give a stimulant.



POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Arnica (Cont.)</b>		Keep the patient warm and quiet.
<b>Arsenic</b> Used in hardening metals, in alloys, rat poisons, fly-paper, for trees and garden sprays, in dyes, etc.	Pain in the throat and stomach, nausea and vomiting, pallor, weak pulse, abdominal cramps, thirst, coma, convulsions, and collapse.	Give an emetic of mustard and water, follow with Epsom salts, and repeat several times; give a wineglass of freshly prepared hydrated oxide of iron and magnesia and repeat the emetic, give castor oil and the whites of eggs and milk, follow with a stimulant. Keep the patient warm and quiet. BAL is the preferred antidote to be administered by a physician.
<b>Aspirin</b> Used to reduce fever and relieve pain.	Rapid breathing, nausea, vomiting, thirst, headache, irritability, delirium, convulsions, coma.	Give universal antidote; wash stomach with a solution of 4 grains of potassium permanganate; wash additionally with 5% sodium bicarbonate solution.
<b>Atropine</b> Used to relieve pain, and as a respiratory stimulant.	Excessive thirst and dryness of the mouth and throat, difficulty in swallowing, dry, flushed skin, dilated pupils, convulsions, coma, and collapse.	Give an emetic of mustard and water, give $\frac{1}{4}$ teaspoonful tannic acid in water or strong tea, repeat the emetic, apply external heat, give a stimulant. Keep the patient warm and quiet.
<b>Barbital, Barbiturates</b> Used as sedative, and as relief from pain.	Overdose causes subnormal temperature, low blood pressure, and cyanosis.	Give an emetic of mustard and water, follow with a stimulant of strong black coffee. Keep the patient awake and warm.
<b>Barium Acetate</b> Used as a mordant for printing fabrics.	Nausea and vomiting, abdominal cramps, diarrhea.	Give Epsom salts, and follow with an emetic of mus-

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Barium Acetate (Cont.)</b>	salivation, paralysis of the arms and legs, pallor, weak pulse.	tard and water. Keep the patient warm and quiet.
<b>Barium Carbonate</b> Used in rat poisons, paints, enamels, etc.	Same as Barium Acetate	Same as Barium Acetate
<b>Barium Chloride</b> Uses are similar to those of barium carbonate.	Same as Barium Acetate	Same as Barium Acetate
<b>Barium Sulfide</b> Used as a depilatory, in luminous paints, vulcanizing rubber, etc.	Same as Barium Acetate	Same as Barium Acetate
<b>Barium Sulfite</b> Has a variety of uses in industry.	Same as Barium Acetate	Same as Barium Acetate
<b>Belladonna</b> Its uses are similar to those of atropine.	Same as Atropine	Same as Atropine
<b>Benzene Hexachloride</b> Used as an insecticide.	Vomiting, diarrhea, convulsions, difficulty in breathing.	Give universal antidote. Wash stomach if possible. Give 1 oz. sodium sulfate in water. Hot tea or coffee may be given.
<b>Bismuth Compounds</b> Used medicinally many times as bismuth dressings.	Nausea and vomiting; salivation; a blue line at the junction of the teeth and gums; swelling of the gums, tongue, and throat.	Give an emetic of mustard and water; follow with the whites of eggs and milk; give a stimulant. Keep the patient warm and quiet.
<b>Borates</b> Used in cleansers, soaps, detergents, etc.	Same as Acid, Boric	Same as Acid, Boric
<b>Bromides</b> Like sodium bromide, potassium bromide, ammonium bromide used as drugs.	Mental confusion, nausea, vomiting, stomach pains, delirium, coma.	Give an emetic and gastric lavage. Give 1 oz. sodium sulfate in water and force fluids.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Cadmium</b> Used for plating other metals and alloys.	Nausea, vomiting, diarrhea, headache, stomach pains, salivation.	Give milk or beaten eggs. Give 1 oz. sodium sulfate in 8 oz. water. BAL may be used by a physician.
<b>Caffeine</b> Its main use is as a stimulant.	Headache, restlessness, excitement, mental confusion, pain over the heart, inability to sleep, high blood pressure, strong pulse.	The symptoms usually disappear after use of caffeine is discontinued.
<b>Calcium Hydroxide and Calcium Oxide</b> Used in plasters, cements, mortars, water paints, de-hairing hides, and as an insecticide.	Pain in the throat and stomach, nausea and vomiting, thirst, pallor, weak pulse, collapse.	Same as Ammonium Hydroxide
<b>Camphor Preparations</b> Used for sprains, rheumatism, neuralgia, lumbago, etc.	The odor of camphor is on the breath, burning pain in the throat and stomach, pallor, weak pulse, poor vision, colic, headache, collapse.	Give an emetic of mustard and water, allow the patient to inhale the fumes of diluted ammonia water, repeat emetic and give a stimulant of hot, black coffee. Give artificial respiration if necessary. Keep the patient warm and quiet.
<b>Cantharides or Spanish Fly</b> Medicinal hair tonic and vesicant. (Used externally)	Burning pain in the mouth and throat, nausea and vomiting, cramps, diarrhea, weak pulse, delirium, collapse.	Give an emetic of mustard and water, the whites of several eggs. Give large volumes of water with emetic, and repeat. Keep the patient warm and quiet.
<b>Carbon Dioxide</b> Used in beverages and fire extinguishers, as solid dry ice, and as a refrigerant.	Headache, unconsciousness, failure of respiration and circulation.	Apply artificial respiration, and if available give oxygen with the use of an inhalator. Keep the patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Carbon Monoxide</b> Present in automobile exhaust, and in some industrial gases.	Headache, bluish-red patches on body, unconsciousness, failure of respiration and circulation.	Same as Carbon Dioxide
<b>Carbon Tetrachloride</b> Used in fire extinguishers, dry cleaning, as a solvent, etc.	Nausea and vomiting, headache, dizziness, pallor, weak pulse, subnormal temperature.	Give an emetic of mustard and water; follow with Epsom salts and repeat, give a stimulant; apply artificial respiration if necessary. Keep the patient warm and quiet. Do not give oils or fats
<b>Chloral Hydrate</b> Used to induce sleep. Also known as "knockout drops."	Drowsiness, lassitude, cold hands and feet, nausea and vomiting, headache, stupor, heart failure.	Give an emetic of mustard and water, give about 20 grains of tannic acid in water and repeat emetic; keep awake, warm, and quiet. Do not give alcohol.
<b>Chlordane</b> Used as an insecticide.	Overexcitability, tremors, convulsions, nausea, vomiting, weakness, depression, coma.	Gastric lavage with 2 to 4 quarts water preceded by universal antidote. Or give 1 pint milk or water and induce vomiting. Give 1 oz. sodium sulfate in 8 oz. water. Give hot tea or coffee.
<b>Chlorine and Chlorine Water</b> Used to disinfect and deodorize; a bleach for wood, paper, pulp, cotton, and many other products.	Pain in the throat and stomach, nausea and vomiting, weak pulse, pallor, difficult breathing.	Give an emetic of mustard and water and repeat, give the whites of eggs and milk. Allow the victim to sniff ammonia. Give a stimulant. Keep the patient warm and quiet.
<b>Chloroform</b> Used as an anesthetic, analgesic, antiseptic, and solvent.	Slow, weak pulse becoming ever slower; pallor, dilated pupils, and paralysis of the heart.	Apply artificial respiration if necessary and if available administer oxygen from an inhalator. Keep the patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Cocaine</b> Used to relieve pain	Restlessness, nausea and vomiting, patient may be happy and talkative; pain in the abdomen, convulsions, coma.	Allow the victim to sniff dilute ammonia water. Give medicinal charcoal, hot black coffee, and artificial respiration if needed. Keep the patient warm and quiet.
<b>Codeine</b> Used to lessen pain, calm nerves, and induce sleep.	Nausea and vomiting, weak pulse, pallor, cold, tired, coma, collapse.	Give 10 grains potassium permanganate in pint of water, follow with an emetic of mustard and water; repeat. Apply ice to head and give a stimulant. Apply artificial respiration if necessary. Keep the patient warm, quiet and awake.
<b>Copper Acetate or Cupric Acetate</b> Used in the manufacture of pigments, fungicides, algicides, and insecticides, in dyeing and printing fabrics, etc.	Same as Copper Acetoarsenite	Same as Copper Acetoarsenite
<b>Copper Acetoarsenite</b> Used as a pigment, an insecticide, and a wood preservative.	Nausea and vomiting, pallor, diarrhea, symptoms of collapse and heart failure.	Give egg whites or milk abundantly, large quantities of water. Best antidote is potassium ferrocyanide (5-15 grains) in water.
<b>Copper Arsenite or Cupric Arsenite</b> Its uses are similar to those of copper acetoarsenite and cupric acetate.	Same as Copper Acetoarsenite	Same as Copper Acetoarsenite
<b>Copper Sulfate or Cupric Sulfate</b> Its uses are similar to those of copper acetoarsenite, cupric acetate, and cupric arsenite.	Same as Copper Acetoarsenite	Same as Copper Acetoarsenite
<b>Creolin. See Cresols.</b> Water emulsion of phenolics (cresols)	Same as Phenol	Same as Phenol

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Creosote.</b> See Cresols.	Same as Phenol	Same as Phenol
<b>Cresols</b> Used as disinfectants, germicides, and deodorants.	Same as Phenol	Same as Phenol
<b>Croton Oil</b> Used to induce patients to take medicines when not willing or able to swallow	Nausea and vomiting, weak pulse, pallor, severe griping pains, violent purging, and collapse.	Give an emetic of mustard and water, using quantities of water, follow with whites of eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Cyanides</b> Potassium, sodium and other salts.	Same as Acid, Hydrocyanic	Same as Acid, Hydrocyanic
<b>2,4-D</b> Used as a weed killer.	Irritation of eyes, intestinal disturbance, muscle stiffness, paralysis, coma.	Gastric lavage. Give universal antidote and then an emetic.
<b>D-D</b> Used as soil fumigant.	Abdominal pains, and chest congestion when ingested. Gasping, coughing, resistance to breathing, tearing, respiratory distress, when inhaled.	Gastric lavage with water. Use demulcent like alumina gel. Do not use fats or oils.
<b>DDT</b> Used as an insecticide.	Vomiting and partial paralysis of extremities, headache, convulsions.	Give universal antidote, then gastric lavage if convulsions are not imminent. Give $\frac{1}{2}$ to 1 oz. sodium sulfate in 8 oz. water. Force fluids and give hot tea or coffee. Do not give oils or fats or use powerful stimulants.
<b>Dieldrin</b> Used as an insecticide.	Same as Chlordane	Same as Chlordane
<b>Digitalis</b> Used as a cardiac stimulant.	Nausea and vomiting, pallor, diarrhea, pain in the abdomen, weak pulse, poor vision, headache, dizziness, and collapse.	Give an emetic of mustard and water, 60 grains of tannic acid in a pint of water; repeat emetic; apply artificial respiration if

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Digitalis (Cont.)</b>		necessary. Keep patient warm and quiet.
<b>Dinitro-o-Cresol</b> Used as a selective weed killer and insecticide.	Same as Dinitrophenol	Same as Dinitrophenol
<b>Dinitrophenol</b> Used as an insecticide and weed killer.	Thirst, fatigue, excessive sweating, nausea, vomiting, abdominal pains, high temperature, difficulty in breathing, restlessness, convulsions, prostration.	Gastric washing with 5% sodium bicarbonate solution. Give $\frac{1}{2}$ to 1 oz sodium sulfate. Or induce vomiting. Use cold compresses or cold bath to reduce fever. Give hot tea or coffee.
<b>Disulfiram (Antabuse)</b> Used to discourage the drinking of alcoholic beverages.	Breathlessness, flushing, sweating, rapid heart action, nausea, vomiting, low blood pressure, difficulty in breathing, convulsions.	Gastric lavage, if done promptly. Artificial respiration and oxygen.
<b>Ergot</b> Used to check bleeding from uterus or to contract the uterus in childbirth.	Nausea and vomiting, cramplike pains low in the abdomen, diarrhea, itching and tingling of the skin, weak pulse, heart pains, shortness of breath, muscle spasms and possibly convulsions, and coma before death.	Give an emetic of mustard and water, medicinal charcoal, castor oil, a stimulant. Keep the patient warm and quiet.
<b>Ether</b> Used as a general anesthetic, a stimulant, a solvent, cleaning agent, etc.	Same as Chloroform	Same as Chloroform
<b>Ethylene Glycol</b> Used as antifreeze.	Initially, the same as Intoxication by alcohol, followed by depression, vomiting, cyanosis, stupor, prostration, convulsions, coma.	Induce vomiting or use gastric lavage. Give oxygen, if necessary.
<b>Fluorides</b> Used as insecticides.	Same as Sodium Fluoride	Same as Sodium Fluoride

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Fluoroacetates</b> Used as rat poisons.	Same as Sodium Fluoroacetate	Same as Sodium Fluoroacetate
<b>Formaldehyde</b> Used in embalming fluids, for hardening films, as a germicide, antiseptic, and deodorant.	Nausea and vomiting, clammy skin, weak pulse, pallor, burning in the mouth and throat, and collapse.	Give aromatic spirits of ammonia in water, medicinal charcoal; follow with the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Gasoline</b> Has many uses, the greatest being as a fuel.	Nausea and vomiting, headache, giddiness, affected vision; in general the symptoms greatly resemble drunkenness.	Give an emetic of mustard and water; follow with Epsom salts; repeat the emetic; give a stimulant of black coffee. Apply artificial respiration if needed. Keep the patient warm and quiet.
<b>Heptachlor</b> Used as an insecticide.	Same as Chlordane	Same as Chlordane
<b>Heroin</b> Used as a sedative and antispasmodic.	Same as Codeine	Same as Codeine
<b>Hydrogen Peroxide</b> Used in medicine and also as a bleaching agent, an oxidizing agent, an antiseptic, and a catalyst.	Nausea and vomiting, pallor, weak pulse.	Give an emetic of mustard and water; follow with Epsom salts, repeat the emetic, and a stimulant. Keep the patient warm and quiet.
<b>Hydrogen Sulfide</b> Used as a reducing agent.	Headache, nausea and vomiting, greenish face, weak pulse, coma, and respiratory failure.	Apply artificial respiration; if an inhalator is available allow the patient to inhale the oxygen from it; also allow the patient to inhale chlorine fumes. Keep the patient warm and quiet.
<b>Hypochlorites</b> Used as bleaches, disinfectants, and deodorizers.	Same as Chlorine	Same as Chlorine



POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Iodine</b> Used in medicines, also as an antiseptic.	Metallic taste in the mouth, nausea and vomiting; pallor, sense of heat in the mouth, throat and stomach, dilated pupils, cyanosis, convulsions; and collapse.	Give the whites of several eggs and milk, an emetic of mustard and water, and repeat several times. Keep the patient warm and quiet.
<b>Iodoform</b> Used as an antiseptic.	Headache, rapid, weak pulse, pallor, dizziness; may attempt suicide, collapse.	Give baking soda and water, follow with an emetic of mustard and water and repeat, give a stimulant. Keep the patient warm and quiet.
<b>Kerosine [Kerosene]</b> Used as an insecticide, solvent, fuel, and dry cleaner.	Same as Gasoline	Same as Gasoline
<b>Lead Salts</b> Have many uses in industry.	Headache; metallic taste in mouth and throat; nausea and vomiting, blue line on the gums, constricted throat; diarrhea, anemia, and paralysis may appear.	Give an emetic of mustard and water, follow with Epsom salts and repeat emetic, give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Lye or Sodium Hydroxide</b> Used extensively in industry and in the home.	Same as Ammonium Hydroxide	Same as Ammonium Hydroxide
<b>Lysoform</b> Is a mixture of cresols and formaldehyde.	Same as Cresols and Formaldehyde	Same as Cresols and Formaldehyde
<b>Lysol</b> Used as a disinfectant.	Same as Cresols	Same as Cresols
<b>Malathion</b> Used as an insecticide.	Same as Parathion	Same as Parathion
<b>Mercuric Oxide, Red</b> Used in medicine and industry.	Same as Mercury Bichloride	Same as Mercury Bichloride
<b>Mercuric Oxide, Yellow</b> Used in medicines and industry.	Same as Mercury Bichloride	Same as Mercury Bichloride

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Mercurous Chloride</b> A powerful antiseptic.	Same as Mercury Bichloride	Same as Mercury Bichloride
<b>Mercury Bichloride</b> Has many uses in medicine. Also used in various industries.	Metallic taste in the mouth; nausea and vomiting; thirst; diarrhea; weak pulse; slow, shallow breathing, and collapse.	Give an emetic of mustard and water and repeat several times using quantities of water, follow with the whites of eggs, and a stimulant. Keep the patient warm and quiet. (Preferred antidote is BAL but sodium formaldehyde sulfoxylate given in accordance with directions accompanying the drug is also useful)
<b>Methanol</b> See Alcohol, Methyl.		
<b>Methyl Alcohol</b> See Alcohol, Methyl.		
<b>Methyl Salicylate</b> Used as drug and flavoring agent.	Same as Aspirin	Same as Aspirin
<b>Morphine</b> Used to lessen pain, calm nerves, induce sleep, etc.	Same as Codeine	Same as Codeine
<b>Mushroom Poisoning</b> Toadstools.	Violent abdominal pains; nausea and vomiting; diarrhea; slow, weak pulse, jaundice; and collapse.	Give an emetic of mustard and water, follow with a large dose of Epsom salts; repeat procedure; give a stimulant. Keep the patient warm and quiet
<b>Naphthalene</b> In moth balls; in dye, resin, and plastic industries.	Restlessness, depression, twitching, the urine is brown to black, weak pulse, pallor, coma, and snoring.	Give an emetic of mustard and water; repeat several times, follow with milk or oatmeal and stimulant. Keep the patient warm and quiet.
<b>Nicotine</b> Used as a plant spray.	Pallor, tremors, palpita	Give tannic acid and me-

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
Nicotine (Cont.)	tions, headaches, dizziness, respiratory paralysis, and coma.	dicinal charcoal, and a stimulant; apply ice to the head. Keep the patient warm and quiet.
Nitrous Fumes See Chapter 5		
Opium Used to lessen pain, calm nerves, induce sleep, etc.	Same as Codeine	Same as Codeine
Oxalic Acid See Acid, Oxalic.		
Parathion Used as an insecticide.	Headache, giddiness, blurred vision, weakness, nausea, cramps, diarrhea, anxiety, abnormal contraction of pupil of eye, tearing, salivation, cyanosis, muscle twitches, convulsions, coma.	Gastric lavage, or give a quart of water or milk and induce vomiting. Follow by 1 oz. of sodium sulfate in 8 oz. of water as cathartic.
Phenacetin Uses are similar to those of acetanilid	Same as Acetanilid	Same as Acetanilid
Phenol Used as an antiseptic, disinfectant, and deodorant.	Whitish burns on the mouth, pains in the throat and stomach, nausea and vomiting, dizziness, pallor, weak pulse, shallow breathing, depression, and unconsciousness.	Give an emetic of mustard and water, use quantities of water and repeat the emetic several times, follow with large glass of Epsom salts, give the whites of several eggs and milk. Keep the patient warm and quiet. Do not give oils.
Phosphate Esters Used as insecticides.	Same as Parathion	Same as Parathion
Phosphorus, Red Its uses are similar to those of white phosphorus.	Same as White Phosphorus	Give an emetic of mustard and water and repeat several times, follow with the whites of several eggs in water. Keep the patient warm and quiet

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Phosphorus, White</b> Used in fireworks, poisons for mice, rats, etc.	Nausea and vomiting, a garlic taste, headache, pallor, weak pulse, diarrhea, vomitus luminous in dark, collapse.	Give copper sulfate (3 grains) every 5 minutes until vomiting occurs; give an emetic of mustard and water and repeat; follow with the whites of eggs in water. Keep the patient warm and quiet. Give no oils, fats or milk.
<b>Picric Acid</b> Used in matches, explosives, in the leather industry, and in the manufacture of textile mordant.	Skin yellow where it contacts the acid, weak pulse, pallor, nausea and vomiting convulsions, and collapse.	This is not an acid, therefore do not give the general treatment for acids. Give the whites of several eggs, and large quantities of Epsom salts. Keep the patient warm and quiet.
<b>Poison Ivy, Poison Oak, Poison Sumac</b> See Chapter 6		
<b>Potassium Binoxalate or Salt of Sorrel</b> Used as an ink and iron-rust remover, and as a mordant in dyeing.	Same as Oxalic Acid	Same as Oxalic Acid
<b>Potassium Carbonate</b> Used in the manufacture of soap, glass, and pottery.	Nausea and vomiting, pain in the throat and stomach, weak pulse, pallor, collapse.	Give lemon juice and emetic of mustard and water and repeat several times; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Potassium Chlorate</b> Used in the manufacture of matches, fireworks, etc.	Nausea and vomiting, pain in the throat and stomach, diarrhea, jaundice, weak pulse, pallor, cyanosis, coma, and collapse.	Give no stimulants Give an emetic of mustard and water and repeat several times, follow with the whites of several eggs. Keep the patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Potassium Hydroxide</b> Used in the manufacture of soap, as paint remover, in printing inks, etc.	Same as Ammonia Water	Same as Ammonia Water
<b>Potassium Permanganate</b> Used for bleaching resins, waxes, oils, fats, etc.	Nausea and vomiting; rapid, weak pulse, pallor, cold, clammy skin; collapse.	Give an emetic of mustard and water, repeat emetic, follow with medicinal charcoal and the whites of several eggs in milk, and a stimulant. Keep the patient warm and quiet.
<b>Sewer Gas</b> See Chapter 5.		
<b>Silver Nitrate</b> Used in the manufacture of indelible inks, silver salts, for resilvering mirrors, etc.	Nausea and vomiting, the vomitus being black, pain in the throat and stomach, weak pulse, pallor, coma and collapse.	Give large quantities of salt water, follow with an emetic of mustard and water and repeat, give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Silver Salts</b> Its uses are great in industry.	Same as Silver Nitrate	For Silver Cyanide: give tablespoonful hydrogen peroxide (3%), whiskey or ammonia in water as a stimulant. For other Silver Salts Same as Silver Nitrate. Follow both with emetic of mustard and water, the whites of eggs, and a stimulant. Keep the patient warm and quiet.
<b>Smokes</b> See Chapter 5.		
<b>Snake Venom</b> See Chapter 6. Resulting from the bite of the rattlesnake, the copper head, or the cottonmouth moccasin.	A sharp burning pain followed by discoloration and swelling; two fang marks usually present, pallor; cold, clammy skin	Immediately apply a restriction band a few inches above the bite (release every 15 minutes for about a minute). Make X-shaped cuts $\frac{1}{2}$ inch deep

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
Snake Venom (Cont.)		and allow the blood to flow; also apply suction. Use no stimulants; do not attempt to cauterize the wound; do not apply potassium permanganate. Keep the patient warm and quiet.
Sodium Carbonate Used in manufacture of soap, glass, sodium salts; as a detergent, water softeners, etc.	Same as Potassium Carbonate	Same as Potassium Carbonate
Sodium Fluoride Used as an insecticide.	Burning cramplike pains in the abdomen, grayish-blue skin, weak pulse, pallor, and collapse.	Give large quantities of water, and lime water and repeat several times, give stimulant and if necessary administer artificial respiration. Keep the patient warm and quiet.
Sodium Fluoroacetate [1083] Used as rat poison.	Nausea, vomiting, mental uneasiness, epileptiform convulsions, uneven heart beat and respiration, exhaustion, coma	Gastric lavage with water, if possible. Give 3 oz. of an equal mixture of whiskey and vinegar to a child and about 9 oz. to an adult. Or give 1 quart of milk and water and induce vomiting. Repeat at least once and then give 1 oz. sodium sulfate in 8 oz. water. If available, physician may use glyceryl monoacetate (monoacetin) intramuscularly or intravenously.
Sodium Hydroxide Used in the manufacture of paper and soap, in oil refining, and numerous other industries.	Same as Ammonium Hydroxide	Same as Ammonium Hydroxide
Sodium Nitrate Used in the manufacture of diazo dyes.	Nausea and vomiting, flushed face, violent then	Allow the patient to breathe fresh air; give an

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
Sodium Nitrate (Cont.)	lessened heart action, dilated pupils, pallor, and collapse.	emetic of mustard and water and repeat, give a stimulant and alternate douches of hot and cold water. Keep the patient warm and quiet.
Spider Poisons See Chapter 6.		
Strychnine Used in medicine, also in rat poisons, etc.	Dilated pupils, terrified expression, fixed grin, weak and feeble pulse, body arches so that it rests on the head and heels, then relaxes, the body shudders, and collapse results.	Do not use emetics or stomach tube. Give 10 grains potassium permanganate in a glass of water, and medicinal charcoal; allow the victim to inhale ether or amyl nitrite. Give strong tea and apply artificial respiration if necessary. Keep the patient warm and quiet
Thallium Salts Used in rat poisons, and ant powders	Severe abdominal pains, purplish gums, foul breath salivation, respiratory failure	Give emetics, hot coffee, artificial respiration. Keep patient warm
Thiocyanates Used as insecticides.	Respiratory difficulty and convulsions.	Give 1 quart of water or milk and induce vomiting. Give 1 oz sodium sulfate in a cup of water. Use artificial respiration. Use gastric lavage if possible.
Toxaphene Used as an insecticide.	Convulsions sometimes preceded by nausea and vomiting. Weakness, lassitude, amnesia	Same as DDT
Turpentine Used in many processes.	Characteristic odor is present, burning sensation in the throat and stomach, nausea and vomiting, skin rash, colic, diarrhea, weak pulse, convulsions, and collapse.	Give an emetic of mustard and water, follow with a large glass of Epsom salts and repeat, give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
<b>Warfarin</b> Used as a rat killer.	Nosebleeds, bruises on elbows and knees, paleness, blood in urine and stools.	Gastric lavage with water followed by 1 oz. sodium sulfate in 1 cup of water. Give vitamin K, 50 to 100 milligrams 3 times daily.
<b>White Lead</b> Used in putty, pigments, etc.	Metallic taste, dry throat, nausea and vomiting, diarrhea, leg cramps, blue line on gums, pallor, weak pulse, anemia, and paralysis.	Give large drink of Epsom salts; follow with an emetic of mustard and water and repeat; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
<b>Zinc Acetate</b> Used in medicine and many industries.	Metallic taste, pain in the stomach, salivation, nausea and vomiting, the vomitus of bloody material, purging, pallor, and collapse.	Same as Copper Acetoarsenite
<b>Zinc Chloride</b> Its uses are similar to those of zinc acetate.	Same as Zinc Acetate	Same as Copper Acetoarsenite
<b>Zinc Phosphide</b> Used as rat poison.	Difficulty in breathing, nausea, vomiting, stomach pains, diarrhea, slow action of heart, circulatory collapse.	Immediate ingestion of weak alkali followed by gastric lavage with 5% sodium bicarbonate solution.
<b>Zinc Sulfate</b> Its uses are similar to those of zinc acetate	Same as Zinc Acetate	Same as Copper Acetoarsenite



# INGREDIENT REFERENCE

*A list of familiar products and the toxic substances that each may contain*

CLASS OF PRODUCTS	MAY CONTAIN
Antifreeze, Auto	Ethylene glycol Methyl alcohol
Antirust preparations	Ammonium sulfide ( <i>see</i> Hydrogen Sulfide) Hydrofluoric acid ( <i>see</i> Acid, Hydrofluoric) Oxalic acid ( <i>see</i> Acid, Oxalic)
Antiseptics	Boric acid and borates ( <i>see</i> Acid, Boric) Cresol Formaldehyde Hydrogen peroxide Hypochlorites ( <i>see</i> Chlorine Water) Iodine Mercurochrome Mercury bichloride Merthiolate Phenol Quaternary ammonium compounds Silver nitrate
Ant pastes and powders	Arsenic compounds Pyrethrum Rotenone Thallium compounds
Bleaches	Acetic acid ( <i>see</i> Acid, Acetic) Calcium hypochlorite ( <i>see</i> Chlorine Water) Oxalic acid ( <i>see</i> Acid, Oxalic) Sodium hypochlorite ( <i>see</i> Chlorine Water)
Brake fluids	Castor oil Ethylene glycol and other glycols and solvents
Canned heat (Sterno)	Denatured ethyl alcohol ( <i>see</i> Alcohol, Ethyl) Methyl alcohol ( <i>see</i> Alcohol, Methyl)
Carburetor cleaners	Denatured alcohol ( <i>see</i> Alcohol, Ethyl and Alcohol, Isopropyl) Chlorinated benzene ( <i>see</i> Benzene Hexachloride) Ethylene glycol Methyl alcohol ( <i>see</i> Alcohol, Methyl)
Cleaning solvents, <i>see</i> Dry cleaners	

CLASS OF PRODUCTS	MAY CONTAIN
Deodorizing solutions and tablets	Formaldehyde
Depilatories	<i>p</i> -Dichlorobenzene (paradichlorbenzene)
	Barium sulfide
	Calcium thioglycollate
Detergents	Alkalies ( <i>see</i> Ammonium Hydroxide and Sodium Hydroxide)
	Borates ( <i>see</i> Acid, Boric)
	Carbonates ( <i>see</i> Sodium Carbonate)
	Phosphates ( <i>see</i> Ammonium Hydroxide and Sodium Hydroxide)
	Quaternary ammonium compounds
	Silicates ( <i>see</i> Sodium Hydroxide)
	"Soapless" soaps ( <i>see</i> Quaternary Ammonium Compounds)
Dishwashing preparations, <i>see</i> Detergents	
Douches, <i>see</i> Disinfectants	
Drain cleaners, <i>see</i> Toilet cleaners	
Dry cleaners	Acetone
	Amyl acetate
	Benzene
	Benzine ( <i>see</i> Gasoline)
	Carbon tetrachloride
	Ethylene dichloride
	Kerosine ( <i>see</i> Gasoline)
	Methyl alcohol ( <i>see</i> Alcohol, Methyl)
	Naphtha ( <i>see</i> Gasoline )
	Petroleum distillates ( <i>see</i> Gasoline)
	Stoddard solvent ( <i>see</i> Gasoline)
	Tetrachloroethylene ( <i>see</i> Carbon Tetrachloride)
	Trichloroethylene ( <i>see</i> Carbon Tetrachloride)
Fire extinguishants	Carbon tetrachloride
	Methyl bromide
	Tetrachloroethylene
Fireworks	Antimony compounds
	Arsenic compounds
	Mercury thiocyanate ("Spit Devils" or "Victory Snakes")
	Phosphides ( <i>see</i> Zinc Phosphide)
	Phosphorus
	Potassium chlorate
Flea powders	DDT and other chlorinated insecticides

CLASS OF PRODUCTS	MAY CONTAIN
Floor wax and polishes, <i>see</i> Polishes	
Fuel tablets	Metaldehyde ( <i>see</i> Paraldehyde) Methenamine Carbon disulfide Carbon tetrachloride Chloropicrin Cyanogen chloride ( <i>see</i> Acid, Hydrocyanic) <i>p</i> -Dichlorobenzene (paradichlorbenzene) Ethylene dichloride Ethylene oxide Ethyl formate Hydrogen cyanide ( <i>see</i> Acid, Hydrocyanic) Methyl bromide Propylene dichloride ( <i>see</i> D-D) Trichloroethylene ( <i>see</i> Carbon Tetrachloride)
Fumigants	Deodorized kerosine ( <i>see</i> Gasoline) Methylated spirit ( <i>see</i> Alcohol, Methyl) Ammonium hydroxide Ammonium nitrate ( <i>see</i> Sodium Nitrate) Lead compounds <i>p</i> -Phenylenediamine (paraphenylenediamine) Pyrogallol Sodium hypochlorite ( <i>see</i> Chlorine Water)
Hair brilliantines	Denatured alcohol ( <i>see</i> Alcohol, Ethyl; Alcohol, Methyl)
Hair colorings and dyes	Shellac Acetic acid ( <i>see</i> Acid, Acetic) Denatured alcohol ( <i>see</i> Alcohol, Ethyl; Alcohol, Isopropyl; Alcohol, Methyl) <i>Cantharides</i> Isopropyl alcohol ( <i>see</i> Alcohol, Isopropyl) Methylated spirit ( <i>see</i> Alcohol, Methyl) beta-Naphthol Pilocarpine
Hair lacquers	Acetic acid ( <i>see</i> Acid, Acetic) Potassium bromate Potassium persulfate Sodium hexametaphosphate Sodium perborate
Hair lotions	Denatured alcohol ( <i>see</i> Alcohol, Ethyl; Alcohol, Methyl)
Hair wave neutralizers	
Hair shampoos <i>See also</i> Detergents	

CLASS OF PRODUCTS	MAY CONTAIN
Hair shampoos (Cont.)	Sodium hexametaphosphate
Hair wave solutions	Ammonium thioglycollate and other thioglycollates
	Sodium carbonate
	Sodium sulfite
Hair straighteners	Potassium hydroxide
	Sodium hydroxide
Hat bleach	Oxalates ( <i>see</i> Acid, Oxalic)
Headache remedies	Aspirin
	Acetanilid
	Acetophenetiden
	Antipyrine
	Barbiturates
	Bromides
	Codeine
	Caffeine
Hookworm remedies	Carbon tetrachloride
Indelible inks and pencils	Aniline dyes
	Silver nitrate
Ink eradicator	Hypochlorites ( <i>see</i> Chlorine Water)
	Oxalates ( <i>see</i> Acid, Oxalic)
Ink, marking and laundry	Aniline
	Phenol
	Silver salts
Ink remover solvents	Acetic acid ( <i>see</i> Acid, Acetic)
	Alcohols ( <i>see</i> Alcohol, Ethyl; Alcohol, Methyl)
	Esters ( <i>see</i> Ethyl Acetate)
	Halogenated hydrocarbons ( <i>see</i> Carbon Tetrachloride)
	Hydrocarbons ( <i>see</i> Gasoline; Benzene)
	Oxalic acid ( <i>see</i> Acid, Oxalic)
Inks	Aniline
	Iron gallate
	Phenol
	Silver nitrate
	Soda ash (sodium carbonate)
	Tannin
Insecticides	Arsenic compounds
(aerosols, pastes, powders, and sprays)	Benzene hexachloride
	Chlordane
	Chlorinated hydrocarbons ( <i>see</i> Carbon Tetrachloride)
	Cyanides ( <i>see</i> Acid, Hydrocyanic)
	DDT

CLASS OF PRODUCTS	MAY CONTAIN
Insecticides (Cont.)	<p> Dieldrin  Dinitro-<i>o</i>-cresol  Dinitrophenol  Fluorides (<i>see</i> Sodium Fluoride)  Heptachlor  Kerosine  Lead compounds  Malathion (<i>see</i> Parathion)  Parathion  Phenol and cresols  Sodium fluoride  Toxaphene  Tetraethyl pyrophosphate (<i>see</i> Parathion)  Thallium compounds </p>
Insect repellents	<p> Camphor  Cedar gum  Citronella oil  <i>p</i>-Dichlorobenzene (paradichlorbenzene)  Dimethyl phthalate  Naphthalene </p>
Jewelry cleaners	<p> Ammonium hydroxide  Isopropyl alcohol (<i>see</i> Alcohol, Isopropyl)  Ketones (<i>see</i> Acetone)  Petroleum solvents (<i>see</i> Gasoline) </p>
Lacquer removers, <i>see</i> Paint removers	
Leather preservatives	<p> Benzene  Methyl alcohol (<i>see</i> Alcohol, Methyl)  Naphtha (<i>see</i> Gasoline)  Neatsfoot oil  Tall oil </p>
Lighter fluid	Petroleum hydrocarbons ( <i>see</i> Gasoline)
Matches	<p> Iron peroxide  Manganese dioxide  Potassium dichromate  Phosphorus sesquisulfide (<i>see</i> Zinc Phosphide)  Red phosphorus (<i>see</i> Phosphorus, Red)  Sulfur </p>
Metal cleaners and polishes	<p> Ammonium hydroxide  Caustic soda (<i>see</i> Sodium Hydroxide)  Hydrochloric acid (<i>see</i> Acid, Hydrochloric)  Phosphoric acid (<i>see</i> Acid, Phosphoric)  Sulfamic acid (<i>see</i> Acid, Acetic) </p>

CLASS OF PRODUCTS	MAY CONTAIN
Metal cleaners and polishes (Cont.)	Sulfuric acid ( <i>see</i> Acid, Sulfuric)
Moth balls	Soda ash ( <i>see</i> Sodium Carbonate)
	Camphor
	<i>p</i> -Dichlorobenzene (paradichlorbenzene)
	Naphthalene
Nail polish and solvents	Alcohols ( <i>see</i> Alcohol, Ethyl; Alcohol, Methyl; Alcohol, Isopropyl)
	Alkalies ( <i>see</i> Ammonium Hydroxide; Sodium Hydroxide)
	Dibutyl phthalate
	Esters ( <i>see</i> Ethyl Acetate)
	Ether
	Ketones ( <i>see</i> Acetone)
	Nitrocellulose
Paint brush cleaners	Acetone
	Alkalies ( <i>see</i> Ammonium Hydroxide; Sodium Hydroxide)
	Alcohols ( <i>see</i> Alcohol, Ethyl; Alcohol, Isopropyl; Alcohol, Methyl)
	Cresols
	Dipentene ( <i>see</i> Turpentine)
	Methyl alcohol ( <i>see</i> Alcohol, Methyl)
	Naphthalene
	Sodium chromate
	Toluene
	Turpentine
Paint removers	Alkalies ( <i>see</i> Ammonium Hydroxide; Sodium Hydroxide)
	Amyl alcohol ( <i>see</i> Alcohol, Ethyl)
	Amyl acetate
	Amylene dichloride ( <i>see</i> Carbon Tetrachloride)
	Benzene
	Butyl acetate
	Butyl alcohol ( <i>see</i> Alcohol, Ethyl)
	Carbon tetrachloride
	Kerosine ( <i>see</i> Gasoline)
	Methyl alcohol ( <i>see</i> Alcohol, Methyl)
	Methylene chloride ( <i>see</i> Carbon Tetrachloride)
	Toluene
Paints and varnishes	Aniline dyes
	Antimony compounds
	Arsenic compounds
	Chromium compounds

CLASS OF PRODUCTS

MAY CONTAIN

Paints and varnishes (Cont.)

Hydrocarbons, aromatic (*see* Benzene)  
Lead compounds  
Methyl alcohol (*see* Alcohol, Methyl)  
Mineral spirits (*see* Gasoline)  
Naphtha (*see* Gasoline)  
Turpentine

Paint solvents and thinners

Alcohols (*see* Alcohol, Ethyl; Alcohol, Methyl)  
Aromatic hydrocarbons (*see* Benzene)  
Coal-tar naphtha (*see* Benzene)  
Esters (*see* Ethyl Acetate)  
Ketones (*see* Acetone)  
Mineral spirits (*see* Gasoline)  
Paraffin hydrocarbons (*see* Gasoline)  
Turpentine

Permanent wave solutions, *see*  
Hair wave solutions

Photographic developers

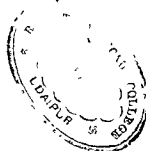
Hydroquinone  
Metol  
*p*-Phenylenediamine (paraphenylenedia-  
mine)

Plastic cements, menders, and  
glues

Acetone  
Carbon tetrachloride  
Cellulose acetate  
Chloroform  
Dibutyl phthalate  
Ether  
Ethylene dichloride  
Formaldehyde  
Nitrocellulose  
Polyvinyl acetate  
Toluene

Polishes and waxes

Alkali (*see* Ammonium Hydroxide;  
Sodium Hydroxide)  
Butyl alcohol (*see* Alcohol, Isopropyl)  
Cellosolve  
Isopropyl alcohol (*see* Alcohol, Isopropyl)  
Kerosine (*see* Gasoline)  
Mineral spirits (*see* Gasoline)  
Naphtha (*see* Gasoline)  
Nitrobenzene  
Oxalic acid (*see* Acid, Oxalic)  
Stoddard solvent (*see* Gasoline)  
Turpentine



CLASS OF PRODUCTS	MAY CONTAIN
Rat poisons and killers, <i>see</i> Rodenticides	Calcium cyanide ( <i>see</i> Acid, Hydrocyanic)
Rodenticides	Arsenic compounds
	Barium carbonate
	Phosphorus
	Potassium cyanide ( <i>see</i> Acid, Hydrocyanic)
	Sodium cyanide ( <i>see</i> Acid, Hydrocyanic)
	Sodium fluoroacetate (1080)
	Thallium compounds
	Warfarin
	Zinc phosphide
Roach powders, <i>see</i> Insecticides	
Rubber cements, <i>see</i> Plastic cements	
Rubbing alcohol	<i>See</i> Alcohol, Ethyl; Alcohol, Isopropyl
Rug cleaners	Carbon tetrachloride
	Trichloroethylene
Shampoos, <i>see</i> Hair shampoos	
Shoe polishes and cleaners	Nitrobenzene
	Turpentine
	Aniline
	Nitrobenzene
	D D
	Dichloroethyl ether
	Hydrochloric acid ( <i>see</i> Acid, Hydro- chloric)
	Zinc salts
	Denatured alcohol ( <i>see</i> Alcohol, Ethyl; Alcohol, Methyl)
	Methyl salicylate
	Hydrochloric acid ( <i>see</i> Acid, Hydro- chloric)
	Sodium hydroxide
	Sulfuric acid ( <i>see</i> Acid, Sulfuric)
	Cellosolve
	Methyl alcohol ( <i>see</i> Alcohol, Methyl)
	Borax ( <i>see</i> Acid, Boric)
	Calcium hypochlorite
	Sodium bicarbonate
	Sodium carbonate
	Sodium hydroxide
	Sodium hexametaphosphate
	Trisodium phosphate
Typewriter cleaners	
Varnishes, <i>see</i> Paints	
Washing powders	
<i>See also</i> Detergents	



CLASS OF PRODUCTS

MAY CONTAIN

Waxes and polishes, *see* Polishes  
and waxes

Wax removers, *see* Paint re-  
movers

Weed killers

Arsenic compounds

Ammonium sulfamate

2,4-D. salts, esters, and alkanolamine com-  
pounds

Dinitrophenol

Sulfamic acid

# 5

## INDUSTRIAL HAZARDS

Industry is confronted with many hazards, so that disregard of safety in the plant is particularly dangerous. Six major types of accidents and injuries are encountered:

Asphyxiation  
Chemical burns  
Dermatitis

Explosion  
Fire  
Poisoning

Some chemicals may cause several of these six accidents or injuries and are hazards while in use, in storage, and during transportation.

**Hazard Factors.** With the rapid advances in chemical fields today comes a responsibility for handling different, unfamiliar chemicals; the usual well-known solvents and chemicals are being replaced by new, strange substitutes whose dangerous properties are sometimes little known to the chemical worker. If casualties and accidents are to be kept in check, serious consideration must be given to these new hazards, by the management as well as by the employee.

A number of factors influence the extent of industrial poisonings; some concern the employee, while others involve the conditions under which the work is performed. A consideration of each of these factors follows.

**Alcohol.** Most safety directors agree that alcoholics do definitely lower the standards of plant safety records, and also have a greater susceptibility to certain poisons.

**Atmospheric Conditions.** Air hygiene is one of the most important factors in the health of the employee. The temperature, cleanliness of the air, and humidity play an important part in healthy working conditions. When toxic substances are removed at or near their point

of origin, it is obvious that the chances of poisoning are minimized.

**Food.** It is an established fact that poison is absorbed more rapidly when the stomach is empty than when full. The English, for instance, years ago recognizing that food in the stomach was one of the best preventive measures against poisoning, supplied cocoa and milk to workers in plants where the danger from absorption of certain poisons was high.

**Heat.** Heat increases the action of chemicals and the speed with which they are absorbed. Heat and humidity also lower the individual's resistance and increase the amount of vapors absorbed by the body.

**Hours.** Long hours on the job increase the risk of poisoning. This is true both because the dose of poison per day is increased, and the opportunity of eliminating it at night is decreased. A worker will, of course, absorb more poison in twelve hours than he would in eight hours; and during the subsequent off-work period, he would eliminate less in twelve hours than in sixteen hours.

**Sex.** Studies have shown that women employed in certain industries not only succumb more rapidly but also suffer more severely from industrial poisons than do men.

In the past few years much of the danger involved in the chemical industry has been eliminated as a result of engineering improvements, good management, and safe practices.

### POISONOUS CHEMICALS IN INDUSTRY

In preceding chapters we discussed those poisons that are generally swallowed by accident or with suicidal intent or given for homicidal purposes. Here we discuss poisoning of a different kind. When persons are poisoned on the job, it is usually by inhalation or absorption. Many times there are no signs of poisoning for days and weeks, until the concentration of poison in the body has reached the tolerance limit. From this time on, chronic symptoms appear, and medical attention is necessary. *For such chronic industrial poisoning, very little should be done until the physician arrives. Call him at once.*

While it is obviously impossible to describe here all of the industrial chemicals that are the products of our modern civilization, descriptions will be given for some one hundred and fifty common industrial chemicals. The chemicals and their toxic doses are given in subse-

TABLE 5. CHEMICALS, THEIR POTENTIAL HAZARD

Chemical	Inflammable				Toxic		
	Flashpoint °F.	Underwriters' Lab. Classification	Explosive	Special (see note)	Ingestion	Inhalation	Skin Contact
Acetic acid .....	115	.	.	.	X	.	X
Acetone .....	0	90	X	.	X	X	X
Amyl acetate .....	77	55 60	.	.	X	X	.
Amyl alcohol .....	100	40	X	.	X	X	.
Aniline .....	168	.	.	.	X	X	X
Benzene (benzol) .....	12	.	X	.	X	X	.
Bromine .....	—	.	.	.	X	X	X
Butyl acetate .....	72	.	X	.	X	X	.
Butyl alcohol .....	82	40	X	.	X	X	.
Carbon disulfide .....	—22	110	X	.	X	X	X
Carbon tetrachloride .....	—	0	.	.	X	X	.
Cellosolve .....	101	.	X	.	X	.	.
Cellosolve acetate .....	121	.	X	.	X	.	.
Chloroform .....	—	.	.	.	X	X	.
Chromic acid .....	—	.	.	A	X	X	X
Cresol .....	178	.	.	.	X	X	X
Dichlorethylene .....	43	.	X	.	X	X	.
Ethyl acetate .....	24	.	X	.	X	.	.
Ethyl alcohol .....	55	70	X	.	X	X	.
Ethyl chloride .....	—59	.	X	.	X	X	.
Ethyl ether .....	—49	100	X	.	X	X	.
Ethylene dichloride .....	56	60 70	X	.	X	X	.
Formic acid .....	150	.	X	.	X	X	X
Glycerin .....	320	.	.	.	.	.	.
Hexane .....	—15	.	X	.	X	.	.
Hydrochloric acid (muriatic) .....	—	.	X	.	X	X	X
Hydrocyanic acid .....	0	.	X	.	X	X	X
Hydrofluoric acid .....	—	.	.	.	X	.	X
Hydrogen peroxide .....	—	.	.	A	X	.	X
Mercury .....	—	.	.	.	X	X	X
Methyl alcohol .....	52	.	X	.	X	X	.
Methylene chloride .....	—	.	.	.	X	X	.
Nitrobenzene .....	190	.	.	.	X	X	X
Nitric acid .....	—	.	.	A	X	X	.
Pentachlorethane .....	—	.	.	.	X	X	X
Sulfuric acid .....	—	.	.	A	X	X	.
Tetrachlorethane .....	—	.	.	.	X	X	.
Tetrachlorethylene (perchlorethylene) .....	—	0	.	.	X	X	.
Toluene (toluol) .....	40	75 80	X	.	X	X	.
Water .....	—	.	.	.	.	.	.
Xylene (xylol) .....	63	.	X	.	X	X	.

KEY: X = considered a hazard. . = not especially a hazard. A = nonflammable, but may cause fire if it comes in contact with organic substances.

REFERENCES: National Fire Protection Association; U. S. Department of Labor; Associated Factory Mutual Fire Insurance Company.

quent pages and have been taken from a number of publications, particularly M. B. Jacobs: *Analytical Chemistry of Industrial Poisons, Hazards, and Solvents*, 2d ed., Interscience Publishers, Inc. (New York City), 1949; this volume is especially recommended for its critical analysis of the literature in the field, and for its many references to original papers.\*

**Chemicals and Industries Where Used.** The reader's attention is directed to pages 152-156 where the various chemicals discussed in this chapter are listed. The industries in which these chemicals are used are described briefly under each chemical. For various names for the same chemical, see the Index.

**Nature of Poisoning.** The poison may be (1) inhaled as a vapor, (2) absorbed through the skin, or (3) swallowed. If the worker is exposed to highly poisonous concentrations of chemicals in the air, or spills on his skin a liquid that is rapidly absorbed through the skin, symptoms of *acute poisoning* result. If the worker is exposed to low concentrations of vapor, or intermittent sprays of liquids, which can be absorbed through the skin, and the poison is of the type that accumulates in the body faster than it can be excreted, *chronic poisoning* results. Chronic poisoning may not be noticeable for days or months, as for example in lead poisoning, or poisoning by radioactive compounds.

The chemicals may be corrosive, toxic, or irritant *liquids*. They may be obstructive, toxic, or irritant *dusts*. They may be *gases, fumes, or vapors* whose poisonous action is asphyxiant, toxic, or irritant.

The poisons may affect (1) the circulatory system or blood stream, (2) such organs as the lungs, stomach, liver, kidneys, and so on, (3) the nervous system, or (4) the skin and mucous membranes.

**Preventive Measures.** Most plant safety directors agree to the following suggestions for lowering the number of poisoning cases by chemicals.

**Personal Cleanliness.** This is important in the control of most diseases and industrial poisonings, and should play a prominent part in any safety program. Frequent washing with soap and water, laundering of clothes, and clean habits are first-line defenses against the

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\* Dangerous concentrations of industrial vapors are quoted, in general, from Jacobs, *Analytical Chemistry of Industrial Poisons, Hazards, and Solvents*. The authors are indebted to the Interscience Publishers, Inc., for permission to quote figures.

hazards of poisoning. The employer is required to provide proper facilities for the employee. Employers in conformance with the law install clean washrooms, showers with hot and cold water, good soaps, clean towels, sanitary drinking fountains, individual lockers, and slippers for walking to and from showers.

*Protective Equipment.* By avoiding contact with irritant materials much of the poisoning can be eliminated. Some of the equipment necessary in this field of safety include gloves, aprons, boots, gauntlets, masks, caps, respirators, and so on. All equipment should be cleaned often and tested for efficiency.

*Protective Creams.* These creams are applied to the hands, arms, and other exposed skin surfaces before exposure. The protective film acts as a barrier against harmful, irritating substances.

*Engineering.* Protection through proper and intelligent engineering will aid greatly toward eliminating vapors, dusts, fumes, and solutions from reaching the worker.

The above-mentioned aids will do much toward controlling industrial poisoning, especially if the worker will use his own good judgment and care. All the safety rules and devices in use today are without value if the worker does not do his part in abiding by the carefully worked out safety precautions.

*Specific Chemical Action.* Certain types of chemicals are known to act specifically on certain portions of the body. The following are a few substances listed under the organs and systems they affect.

#### *General Systemic Poisoning*

arsenic  
carbon disulfide  
lead  
mercury  
methyl alcohol

#### *Circulatory System*

aniline	lead
arsenic	mercury
benzene (benzol)	nitrobenzene
carbon	trinitrotoluene
monoxide	vanadium
dinitrobenzene	

#### *Respiratory System*

ammonia  
chlorine  
cobalt arsenide  
hydrogen sulfide  
nitrous fumes  
silica  
sulfur dioxide

#### *Gastro-Intestinal System*

antimony	mercury
arsenic	nitroamido compounds
benzene (benzol)	tetrachloroethane
cadmium	zinc
chlorinated	
hydrocarbons	
cyanides	
lead	

*Skin*

actinic rays  
anthracene  
benzine  
benzene (benzol)  
chromates  
formaldehyde  
hexamethylenetetramine  
paraphenyldiamine  
turpentine  
tar  
x rays  
zinc chloride

*Organs of Special Sense*

arsenic  
benzene (benzol)  
carbon disulfide  
hydrocyanic acid  
hydrogen sulfide  
lead  
manganese  
mercury  
methyl alcohol  
turpentine

*Skeleton and Joints*

arsenic  
lead  
mercury  
mesothorium  
phosphorus acids (on teeth)  
radium

*Genito-Urinary System*

aniline	nitroglycerin
arsenic	paranitraniline
benzene (benzol)	phenol
beta naphthylamine	turpentine
ether	vanadium
mercury	x-rays

*Brain and Nervous System*

arsenic	manganese
benzine	methyl alcohol
carbon disulfide	naphtha
cyanide	nitroglycerin
dimethyl sulfate	phenol
ether	trichloroethylene
lead	

**Toxic Concentrations.** Let us suppose that a workman has broken a bottle containing a pound of benzene in a room  $10 \times 10 \times 10$  feet. An hour later he discovers that the ventilators are not working, and wishes to know whether he is likely to be poisoned from the exposure. The data given in the following pages enable him to determine this.

He has been working in a concentration of 16 avoirdupois oz. of benzene per 1000 cubic feet. Under Benzene we find that this very exposure may produce serious illness. He should therefore summon a physician.

Two other expressions are more often used by the chemist than the oz. per cu. ft. just given. They are (1) parts by volume of the poisonous vapor per million parts of poisonous air; this is abbreviated to ppm.; and (2) the milligrams of poison per liter of air.

In the descriptions that follow, toxic concentrations are given wherever such information is available in the literature, as summarized in Jacobs' book. The expressions may be converted from

one to another by use of the following, in which  $M$  is the molecular weight of the poison:

$$\text{ppm.} = \frac{24450 \times (\text{mg./liter})}{M}$$

$$\text{mg./liter} = \frac{\text{ppm.} \times M}{24450}$$

$$\text{mg./liter} = \text{avoirdupois oz./1000 cu. ft.}$$

For most poisons the following expression holds true:

Extent of poisoning = exposure time  $\times$  concentration of poison; that is an exposure to 50 ppm. of gas for 30 minutes produces approximately the same poisoning effect as a 60-minute exposure to 25 ppm.

*Allowable concentrations* can be decided only by extensive tests; moreover a concentration that may be *injurious* to one person may be *tolerated* by another individual. Concentrations allowed for safe working conditions are stated in Table 6; these values are those adopted in 1957 as the threshold limits by the American Conference of Governmental Industrial Hygienists. Naturally the toxic concentration is subject to the idiosyncracies of the person exposed.

### THRESHOLD LIMIT VALUES FOR 1958 \*

Values are given in the following tabulation for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an eight-hour working day without injury to health.

These values are based on the best available information from industrial experience, from experimental studies, and, when possible, from a combination of the two. They are not fixed values but are reviewed annually by the Committee on Threshold Limits for changes, revisions, or additions as further information becomes available. Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent only conditions under which it is felt that workers may be repeatedly exposed, day after day, without adverse effect on their health. The figures listed refer to

\* After A. M. A. *Archives of Industrial Health*, September 1957, Vol. 16, pp. 261-265, copyright 1957, by American Medical Association as modified at the meeting of American Conference of Governmental Industrial Hygienists, Atlantic City, 1958.



weighted average concentrations of an eight hour working shift rather than a maximum which is not to be exceeded even momentarily. The amount by which these figures may be exceeded for short periods during the workday depends upon a number of factors, such as the nature of the contaminant, whether very high concentrations even for short periods produce acute poisoning, whether the results are cumulative, the frequency with which high values occur and for what periods of time. All must be taken into consideration in arriving at a decision as to whether a hazardous situation is deemed to exist.

These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air-pollution nuisances.

The Committee welcomes the suggestion of substances to be added to the list and also comments, references, or reports of experience with these materials.

**TABLE 6. RECOMMENDED THRESHOLD LIMIT VALUES**

*(American Conference of Governmental Industrial Hygienists)*

*Gases and Vapors*

SUBSTANCE	PPM <sup>a</sup>	APPROX. MG PER CU M <sup>b</sup>	SUBSTANCE	PPM	APPROX. MG PER CU M.
Acetaldehyde	200	360	Butanone (methyl ethyl ketone)	250	740
Acetic acid	10	25	Butyl acetate		
Acetic anhydride	5	20	(n butyl acetate)	200	950
Acetone	1,000	2,400	Butyl alcohol		
Acrolein	0.5	12	(n butanol)	100	300
Allyl alcohol	5	12	Butylamine	5	15
Allyl chloride	5	15	Butyl Cellosolve		
Allyl propyl disulfide	2	12	(2 butoxyethanol)	50	210
Ammonia	100	70	Carbon dioxide	5,000	9,000
Amyl acetate	200	1,050	Carbon disulfide	20	60
Amyl alcohol			Carbon monoxide	100	110
(isoamyl alcohol)	100	360	Carbon tetrachloride	25	160
Aniline	5	19	Cellosolve		
Arsine	0.05	0.2	(2 ethoxyethanol)	200	710
Benzene (benzol)	25	80	Cellosolve acetate		
Benzyl chloride	1	5	(2-ethoxyethyl acetate)	100	510
Bromine	1	7	Chlorine	1	3
Butadiene					
(1,3 butadiene)	1,000	2,200			

<sup>a</sup> Parts of vapor or gas per million parts of air by volume

<sup>b</sup> Approximate milligrams per cubic meter of air.

APPROX. MG. PER CU. M.			APPROX. MG. PER CU. M.		
SUBSTANCE	PPM.		SUBSTANCE	PPM.	
Chlorine dioxide ....	01		Ethyl acetate .....	400	1,400
Chlorine trifluoride .	01	0.4	Ethyl acrylate .....	25	100
Chlorobenzene (monochloro- benzene) .....	75	350	Ethyl alcohol (ethanol) .....	1,000	1,900
Chloroform .....	100	490	Ethylamine .....	25	45
1-Chloro-1-nitro- propane .....	20	100	Ethylbenzene .....	200	870
Chloropierin .....	1	7	Ethyl bromide . ....	200	890
Chloroprene (2-chloro- 1,3-butadiene) ....	25	90	Ethyl chloride .....	1,000	2,600
Cresol (all isomers) .	5	22	Ethyl ether .....	400	1,200
Cyclohexane .....	400	1,400	Ethyl formate .....	100	300
Cyclohexanol .....	100	410	Ethyl silicate .....	100	850
Cyclohexanone .....	100	400	Ethylene chlorohydrin	5	16
Cyclohexene .....	400	1,350	Ethylenediamine	10	30
Cyclopropane .....	400	690	Ethylene dibromide (1,2 dibromoethane)	25	190
Decaborane .....	0 05	0 5	Ethyleneimine .. ...	5	9
Diacetone alcohol (4-hydroxy-4-methyl- 2-pentanone) .....	50	240	Ethylene oxide .....	50	90
Diborane .....	0 1	0.1	Fluorine . . . . .	0.1	0.2
o-Dichlorobenzene .	50	300	Fluorotrichloro- methane .....	1,000	5,600
Dichlorodifluoro- methane . ....	1,000	4,950	Formaldehyde .....	5	6
1,1-Dichloroethane ..	100	400	Furfural . ....	5	20
1,2 Dichloroethane (ethylene dichloride) .. ....	100	400	Gasoline . . . . .	500	2,000
1,2 Dichloroethylene	200	790	Heptane (n-heptane)	500	2,000
Dichloroethyl ether .	15	90	Hexane (n hexane) .	500	1,800
Dichloromonofluoro- methane .....	1,000	4,200	Hexanone (methyl butyl ketone) .. .	100	410
1,1-Dichloro-1- nitroethane .....	10	60	Hexone (methyl isobutyl ketone) .	100	410
Dichlorotetra- fluoroethane .....	1,000	7,000	sec-Hexyl acetate ...	100	590
Diethylamine .....	25	75	Hydrazine .. . . .	1	1.3
Difluorodibromo- methane .....	100	860	Hydrogen bromide ..	5	17
Diisobutyl ketone ..	50	290	Hydrogen chloride .	5	7
Dimethylaniline (N dimethylaniline)	5	25	Hydrogen cyanide ..	10	11
1,1-Dimethyl- hydrazine .....	0.5	1	Hydrogen fluoride .	3	2
Dimethyl sulfate ....	1	5	Hydrogen peroxide, 90% . . . . .	1	1.4
Dioxane (diethylene dioxide) .....	100	360	Hydrogen selenide	0 05	0 2
Epichlorohydrin ....	25	90	Hydrogen sulfide ..	20	30
			Iodine . . . . .	0.1	1
			Isophorone . . . . .	25	140
			Isopropylamine . . .	5	12
			Mesityl oxide . . . .	25	100
			Methyl acetate ....	200	610
			Methylacetylene	1,000	1,660
			Methyl acrylate .....	10	35
			Methyl alcohol (methanol) .... .	200	260
			Methyl bromide ...	20	80

SUBSTANCE	PPM	APPROX. MG PER CU. M.		SUBSTANCE	PPM	APPROX. MG PER CU. M.	
Methyl Cellosolve (2 methoxyethanol)	25	80		Phenylhydrazine ....	5	22	
Methyl Cellosolve acetate (ethylene glycol monomethyl ether acetate)	25	120		Phosgene (carbonyl chloride) .....	1	4	
Methyl chloride	100	210		Phosphine ... ..	0.05	0.07	
Methylal (dimethoxy- methane)	1,000	3,100		Phosphorus trichloride	0.5	3	
Methyl chloroform (1,1,1-trichloro ethane) .. ....	500	2,700		Propyl acetate	200	840	
Methylcyclohexane	500	2,000		Propyl alcohol			
Methylcyclohexanol	100	470		(isopropyl alcohol)	400	980	
Methylcyclohexanone	100	460		Propyl ether			
Methyl formate	100	250		(isopropyl ether)	500	2,100	
Methyl isobutyl carbinol (methyl amyl alcohol)	25	100		n-Propyl nitrate	25	110	
Methylene chloride (dichloromethane)	500	1,750		Propylene dichloride (1,2 dichloro- propane) .....	75	350	
Naphtha (coal tar)	200	800		Propyleneimine .....	25	60	
Naphtha (petroleum)	500	2,000		Pyridine ... ..	10	30	
Nickel carbonyl	0.001	0.007		Quinone .. .	0.1	0.4	
Nitric acid ...	5	25		Stibine .. .	0.1	0.5	
p-Nitroaniline .....	1	6		Stoddard solvent ..	500	2,900	
Nitrobenzene ....	1	5		Styrene monomer (phenylethylene)	100	420	
Nitroethane .. .	100	310		Sulfur dioxide .	5	13	
Nitrogen dioxide	5	9		Sulfur hexafluoride	1,000	6,000	
Nitroglycerin	0.5	5		Sulfur monochloride	1	6	
Nitromethane .. .	100	250		Sulfur pentafluoride	0.025	0.25	
2-Nitropropane .. .	50	180		p-Tertiarybutyltoluene	10	60	
Nitrotoluene .....	5	30		1,1,2,2 Tetrachloro- ethane	5	33	
Octane .... .	500	2,350		Tetrahydrofuran	200	590	
Ozone .. .	0.1	0.2		Tetranitromethane	1	8	
Pentane .. .	1,000	2,950		Toluene (toluol)	200	750	
Pentanone (methyl propyl ketone)	200	700		o-Toluidine	5	22	
Perchloroethylene (tetrachloroethylene)	200	1,350		Trichloroethylene	200	1,050	
Phenol .. .	5	19		Trichloropropane	50	300	
				Trifluoromonobromo- methane ... ..	1,000	6,100	
				Turpentine .... .	100	560	
				Vinyl chloride (chloroethylene) ..	500	1,300	
				Xylene (xylol) ...	200	870	



SUBSTANCE	MG. PER CU. M.
Vanadium	
(V <sub>2</sub> O <sub>5</sub> dust) .....	0.5
(V <sub>2</sub> O <sub>5</sub> fume) .....	0.1

Radioactivity. For permissible concentrations of radioisotopes in air, see "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," Handbook 52, U. S. Department of Commerce, National Bureau of Standards, March, 1953. In addi-

SUBSTANCE	MG. PER CU. M.
Warfarin (3 [ $\alpha$ acetylbenzyl]-4-hydroxycoumarin) .....	0.5
Zinc oxide fumes .....	15
Zirconium compounds (as Zr) . . .	5

tion, see "Permissible Dose from External Sources of Ionizing Radiation," Handbook 59, U. S. Department of Commerce, National Bureau of Standards, Sept. 24, 1954.

Revision of the two publications mentioned above is in progress.

### Mineral Dusts

SUBSTANCE	MPPCF <sup>d</sup>
Aluminum oxide .....	50
Asbestos .....	5
Dust (nuisance, no free silica) ..	50
Mica (below 5% free silica) ..	20
Portland cement .....	50
Talc .....	20

SUBSTANCE	MPPCF
Silica	
high (above 50% free SiO <sub>2</sub> ) ...	5
medium (5 to 50% free SiO <sub>2</sub> )	20
low (below 5% free SiO <sub>2</sub> )	50
Silicon carbide .....	50
Soapstone (below 5% free SiO <sub>2</sub> )	20

### TENTATIVE VALUES

SUBSTANCE	PPM <sup>a</sup>	APPROX. MG PER CU. M. <sup>b</sup>
Acetylene tetrabromide	1	14
Allyl glycidyl ether (AGE) .....	10	45
Beryllium .....		2 $\gamma$ /m <sup>3</sup>
Boron trifluoride ....	1	3
n-Butyl glycidyl ether (BGE) ... ..	50	270
Butyl mercaptan .....	10	35
Chloroacetaldehyde .	1	3
Chlorobromomethane (ClBrCH <sub>3</sub> ) ... ..	400	2,100
Diglycidyl ether (DGE)	10	55
Dimethyl formamide .	20	60
Dipropyleneglycol- methylether ... ..	100	600
Ethyl mercaptan ... ..	250	610

SUBSTANCE	PPM	APPROX. MG PER CU. M.
Furfuryl alcohol .....	50	200
Glycidol .....	50	150
Isopropyl glycidyl ether (IGE) .....	50	210
Lithium hydride ..		25 $\gamma$ /m <sup>3</sup>
Methyl mercaptan ..	50	100
$\alpha$ Methyl styrene ..	100	420
Monomethyl aniline	2	9
Paradichlorobenzene	75	450
Perchloromethyl mercaptan .....	0.1	0.8
Phenyl glycidyl ether (PGE) .....	50	310
Propylene oxide ..	100	210
Tertiary butyl alcohol	100	300
Tolylene-2,4- diisocyanate .....	0.1	0.7

<sup>d</sup> Millions of particles per cubic foot of air.

<sup>a</sup> Parts of vapor or gas per million parts of air by volume.

<sup>b</sup> Approximate milligrams per cubic meter of air.

SUBSTANCE	APPROX. MG. PER		SUBSTANCE	APPROX. MG. PER	
	PPM.	CU. M.		PPM.	CU. M.
Triethyl amine .....	25	100	Xylidine .....	5	25
Vinyl toluene .....	100	480	Teflon decomposition products* ..	0	0
Yttrium and inorganic compounds .....		5	Pentaborane ( $B_5H_9$ ) ‡	0	0

**Toxicity of Various Industrial Chemicals.** In Table 7, the relative toxicities of the different chemicals treated in this chapter are indicated by dots. In each case it is the *vapor* (which is always present above any liquid) that is being considered. The dot does not indicate the effect of swallowing a liquid or eating a solid; although in general if the vapor is poisonous the liquid or solid state would be even more so, unless it is of the type that is quickly thrown off by vomiting. The meaning of the dots follows:

• • • *Extremely dangerous:* an hour exposure to even less than 1000 ppm. may produce severe injury.

• • *Dangerous:* an hour exposure to from 1000 to 10,000 ppm. may produce severe injury.

• *Not especially dangerous:* several hours exposure to from 10,000 to 100,000 ppm. may cause severe illness; or substance not volatile enough to cause danger.

*No dot:* insufficient data obtainable.

The reader may be surprised to learn that carbon monoxide, which causes so many deaths, is not violently poisonous (• •). It is so dangerous only because its common concentration about the household (in automobile exhaust or cooking gas) is usually so high—up to 15%.

**TABLE 7. INDUSTRIAL POISONS AND SOLVENTS,  
CLASSIFIED CHEMICALLY**

(For significance of dots see legend immediately above)

**1. Elements (and special compounds associated with them)**

**METALS**

- |                                |                           |
|--------------------------------|---------------------------|
| • • antimony                   | • • • beryllium compounds |
| • • • arsenic                  | • • • cadmium             |
| • • • arsine (arsenic hydride) | • • chromium              |
| • • • beryllium                | • • • chromium compounds  |

\* Until more data are forthcoming, it is important that atmospheric concentrations of these materials to which workers are exposed must be kept as near 0 as possible.

## METALS—CONTINUED

- ...cobalt-60
- copper
- copper compounds
- iron
- ...iron carbonyl
- ...lead
- magnesium
- manganese
- ...mercury
- ...metallic fumes
- nickel
- nickel compounds
- ...nickel carbonyl
- ...plutonium
- ...radium and daughters
- ...stibine (antimony hydride)
- ...strontium
- ...strontium-90
- thallium
- ...thallium compounds
- tin
- uranium
- ...uranium-235
- vanadium
- vanadium compounds
- zinc
- zinc compounds

## NONMETALS

- selenium
- ...selenium oxychloride
- ...hydrogen selenide
- tellurium

## 2. Inorganic compounds containing:

## CARBON

- carbon dioxide
- carbon monoxide
- ...cyanogen
- ...cyanogen chloride
- ...hydrocyanic acid

## HALOGENS

- ...chlorine
- ...bromine
- ...chlorine trifluoride
- ...fluorine
- ...hydrochloric acid
- ...hydrobromic acid
- ...hydrofluoric acid
- ...hydrogen bromide
- ...hydrogen chloride
- ...hydrogen fluoride
- ...iodine
- ...phosgene

## NITROGEN

- ...ammonia
- ...hydrazine
- ...nitric acid

## OXYGEN

- ...hydrogen peroxide (90%)
- oxygen
- ...ozone
- ...peroxides

## PHOSPHORUS

- ...phosphine
- ...phosphorus
- ...phosphorus oxychloride
- ...phosphorus pentachloride
- ...phosphorus trichloride

## SULFUR

- ...carbon disulfide
- ..carbon oxysulfide
- ...hydrogen sulfide
- ...sulfur dioxide
- ..sulfur hexafluoride
- ...sulfur monochloride
- ...sulfur pentafluoride
- ...sulfur trioxide
- ..sulfuryl chloride
- ..thionyl chloride

## 3. Hydrocarbons

## CHAIN (ALIPHATIC) HYDROCARBONS

- ..acetylene
- ..benzine
- ..butane
- ..ethane
- ..ethylene
- ..gasoline
- ..heptane
- ..hexane
- ..methane
- ..naphtha and other petroleum distillates
- ..octane
- ..pentane
- ..propane
- ..Stoddard solvent
- ..turpentine

## RING (AROMATIC) HYDROCARBONS

- ...benzene (benzol)
- ..cyclohexane
- ..cyclohexene
- ..cyclopropane
- ..decalin
- ..ethylbenzene
- ..methylcyclohexane
- ..naphthalene
- ..solvent naphtha
- ..styrene, monomer
- ..tetralin
- ..toluene (toluol)
- ..xylene (xylol)

## 4. Aliphatic (Chain) Derivatives

## ACIDS

- ...acetic acid
- ...acetic anhydride
- ..formic acid
- ..oxalic acid

See also Chapter 3

## ALCOHOLS

- ...allyl alcohol
- ...amyl alcohol
- ..butyl alcohol
- ..diacetone alcohol
- ..ethyl alcohol
- ..isopropyl alcohol
- ..methyl alcohol

See also Chapter 3

## ALDEHYDES AND KETONES

- ..acetaldehyde
- ..acetone
- ...acrolein
- ...formaldehyde
- ...isophorone
- ..mesityl oxide
- ..methyl butyl ketone
- ..methylcyclohexanone
- ..methyl ethyl ketone
- ..methyl isobutyl ketone
- ..methyl propyl ketone



## ESTERS

- amyl acetate
- amyl formate
- amyl phthalate
- butyl acetate
- butyl formate
- butyl phthalate
- dimethyl sulfate
- ethyl acetate
- ethyl acrylate
- ethylene glycol dinitrate
- ethyl formate
- ethyl phthalate
- ethyl silicate
- methyl acetate
- methyl acrylate
- methyl formate
- nitroglycerin
- propyl acetate
- tri-*o*-cresyl phosphate

## ETHERS

- dioxane
- ethylene oxide
- ethyl ether
- isopropyl ether

## GLYCOLS AND GLYCOL ETHERS

- diethylene glycol
- diethylene glycol monoethyl ether
- ethylene glycol
- ethylene glycol monobutyl ether
- ethylene glycol monoethyl ether
- ethylene glycol monomethyl ether

## NITROGEN COMPOUNDS

- butylamine
- diethylamine
- ethylamine
- ethylenediamine
- ethylimine
- isopropylamine
- nitroethane
- nitromethane
- 2 nitropropane
- propyleneimine
- teranitromethane

## HALOGENATED ALIPHATIC COMPOUNDS

*Saturated**Unsaturated**Brominated and Other*

- acetylene tetra-
- chloride
- carbon tetrachloride
- chloropicrin
- chloroform
- 1,1-dichloroethane
- dichloroethyl ether
- dichloromethyl ether
- dichloropropane
- ethyl chloride
- ethylene dichloride
- methyl chloride
- methylene chloride
- 1,1,1-trichloroethane
- acetylene dichloride
- allyl chloride
- chloroprene
- ethylene chloride
- tetrachloroethylene
- trichloroethylene
- vinyl chloride
- ethyl bromide
- ethylene bromide
- ethylene dibromide
- chlorine fluorine compounds
- 1-chloro-1-nitropropane
- 1,1-dichloro-1-nitroethane
- ethylene chlorohydrin

## 5. Aromatic and Ring Derivatives

CHLORINE	NITROGEN	OTHER
••chlorobenzene	•••aniline	•••cresols
•chlorinated di-phenyls	•••dimethylaniline	•cresylic acid
•chlorinated naphthalenes	•dinitrobenzene	•cyclohexanol
••dichlorobenzene	••dinitrochlorobenzene	•cyclohexanone
	•dinitrophenol	••furfural
	•• <i>p</i> -nitroaniline	•hydroquinone
	••nitrobenzene	•methylcyclohexanol
	•nitrochlorobenzene	••phenol
	••nitrotoluene	•pyrocatechol
	• <i>p</i> -phenylenediamine	•pyrogallol
	•picric acid	•resorcinol
	••pyridine	
	••toluidine	
	•trinitrotoluene	

## DATA ON HAZARDOUS CHEMICALS

Acetaldehyde ( $\text{CH}_3\text{CHO}$ ), acetic aldehyde, "aldehyde," or ethylaldehyde is a colorless liquid with a characteristic pungent odor. It is used as an intermediate for many plastics and elastomers, and also for silvering mirrors and in photography. Acetaldehyde is inflammable and in sufficient concentration can cause cyanosis. Paraldehyde is a liquid polymer formed from acetaldehyde.

Acetic Anhydride [ $\text{CH}_3(\text{CO})_2\text{O}$ ] or acetyl oxide is a colorless liquid, resembling glacial acetic acid in odor, symptoms, and many properties. Acetic anhydride is used in making cellulose acetate rayons, dopes, plastics, etc., for general acetylations, and as a solvent for fats and volatile oils. See Acid, Acetic.

Acetone ( $\text{CH}_3\text{COCH}_3$ ), dimethyl ketone, beta-ketopropane, propanone, or pyroacetic ether is a colorless, pleasant-smelling liquid. It is one of the most extensively used solvents for rubber, fats, oils, resins, waxes, cellulose acetate, lacquers, varnishes and rubber cements; as an intermediate for many synthetics; for absorbing acetylene gas, etc. Acetone burns, and the vapors of it explode easily. It is relatively harmless as a poison: for short exposures the vapor is about as toxic as benzene; long exposures may irritate the mucous membranes and cause headaches, fainting, and general poisoning.

Acetylene ( $\text{HC}\equiv\text{CH}$ ) or ethine is an unsaturated hydrocarbon gas

used in welding (oxyacetylene welding) and as an illuminant; it is increasing in importance as a raw material for many polymeric plastics and elastomers; also for acetaldehyde and other synthetics. It is chiefly a fire and explosion hazard; for although it is mildly anesthetic, 50,000 ppm. (53 mg. / liter; 53 avoirdupois oz. / 1000 cu. ft.) can be tolerated for an hour. Dangerously poisonous arsine or phosphine may be present as impurities if the acetylene has been generated from calcium carbide and water.

**Acetylene Dichloride** ( $\text{CHCl}=\text{CHCl}$ ) or dichloroethylene, a colorless solvent with a slightly acrid odor, is used with fats, dry cleaners, insecticides, camphor, and phenol, and also to retard fermentation. In narcotic and anesthetic action it is somewhat less poisonous than carbon tetrachloride.

**Acetylene Tetrachloride** ( $\text{Cl}_2\text{HC}-\text{CHCl}_2$ ), tetrachloroethane, or tetrachloroacetylene (no longer called tetraline because of confusion with tetralin) is an important noninflammable solvent for fats, waxes, oils, resins, rubber, etc. It is also used in the manufacture of paint and varnish removers, photographic films, dry cleaners, fire extinguishers, insecticides, etc. It is a colorless liquid having a suffocating odor. The inhaled vapors have a sweetish taste. It is one of the most poisonous chlorinated hydrocarbons, attacking the nervous system, to cause headaches, insomnia, and dizziness; and the stomach, to cause cramps, nausea and vomiting; and finally producing jaundice and death. A lethal concentration of 7300 ppm. (50 mg. / per liter; 50 avoirdupois oz. / 1000 cu. ft.) should be contrasted with the figure 25,000 for chloroform. The allowable working concentration is 5 ppm.

**Acids.** See Chapter 3 for most industrial acids.

**Acid, Formic** ( $\text{HCOOH}$ ), a colorless, pungent liquid, burns and is dangerously caustic to the skin. It is substituted for acetic acid in coagulating rubber latex, dehairing hides, tanning, and in chemical analysis. Applied externally it blisters the skin; and the blisters may spread. Vapors of it cause lachrymation and irritation of the nose and throat. It is the poison present in the sting of ants and some other insects.

**Alcohols.** See Chapter 3.

**Alkalies.** See Barium, Calcium, Potassium, and Sodium Hydroxides in Chapter 3.

Allyl Chloride ( $\text{CH}_2\text{Cl}-\text{CH}=\text{CH}_2$ ), 3-chloropropylene, or chlorallylene, a colorless to yellowish, pungent, vile-smelling liquid, is extremely poisonous: some guinea pigs were killed by a 4-hour exposure to 300 ppm. (1 mg. / liter; 1 avoirdupois oz. / 1000 cu. ft.). Allyl chloride is one of the more toxic chlorinated hydrocarbons. The threshold limit is 5 ppm.

Ammonia. See Chapter 3.

Amyl Acetate, iso- [ $\text{CH}_3\text{COO}-\text{CH}_2-\text{CH}_2-\text{CH}(\text{CH}_3)_2$ ] or amylacetic ester is the banana or pear oil long used in aluminum-base radiator paints; it is still used in modern bronzing liquids, in lacquers, for dyes, and for flavors. As little as 1 ppm. (0.005 mg. / liter; 0.005 avoirdupois oz. / 1000 cu. ft.) can be detected by its odor, and may cause coughing. One thousand ppm. for one hour irritates the mucous membranes, causing headache, dizziness, and nausea. Allowable working concentration is 200 ppm. Somewhat less irritating is Secondary Amyl Acetate [ $\text{CH}_3\text{COOCH}(\text{CH}_3)\text{C}_2\text{H}_7$ ] a yellowish, pungent solvent for lacquers, which is neither an explosive nor poison hazard, because of the warning of its disagreeable odor. Guinea pigs were affected, but not seriously, by an hour exposure to 10,000 ppm. (50 mg. / liter; 50 avoirdupois oz. / 1000 cu. ft.).

Amyl Formate ( $\text{HCOOC}_5\text{H}_{11}$ ), Butyl Formate ( $\text{HCOOC}_4\text{H}_9$ ), and Ethyl Formate ( $\text{HCOOC}_2\text{H}_5$ ) are colorless liquids used in lacquers, in the artificial leather and silk industries; also in making safety-glass plastic. None are very dangerous (amyl formate is more so than the others) since they warn by irritating the mucous membranes. They affect the central nervous system.

Amyl Phthalate, di-iso- [ $\text{C}_6\text{H}_4(\text{COO}-\text{C}_5\text{H}_{11})_2$ ], Dibutyl Phthalate [ $\text{C}_6\text{H}_4(\text{COO}-\text{C}_4\text{H}_9)_2$ ], Diethyl Phthalate [ $\text{C}_6\text{H}_4(\text{COO}-\text{C}_2\text{H}_5)_2$ ], Dimethyl Phthalate [ $\text{C}_6\text{H}_4(\text{COO}-\text{CH}_3)_2$ ], and Dipropyl Phthalate [ $\text{C}_6\text{H}_4(\text{COO}-\text{C}_3\text{H}_7)_2$ ] are all colorless, oily liquids used widely as plasticizers. Because they do not volatilize to any great extent, they do not appear to be especially harmful. Taken internally they produce nausea and vomiting.

Aniline ( $\text{C}_6\text{H}_5\text{NH}_2$ ) or aminobenzene is an oily solvent with a rather unpleasant odor; its color darkens in the air. Aniline is widely used as an intermediate in the dye, drug, and rubber industries. Acute poisoning, as from an exposure of 200 ppm. (0.8 mg. / liter; 0.8 avoirdupois oz. / 1000 cu. ft.) for an hour, may produce cyanosis, weakness,

mental confusion, intoxication, convulsions, and death. Chronic poisoning may occur either from inhaling the vapor or by absorption through the skin; its symptoms are skin irritation, eczema, anemia, and weak pulse; the blood and urine are brownish. The maximum allowable working concentration is 5 ppm.

**Antimony (Sb).** See Chapter 3.

**Arsenic (As).** For arsenic salts see Chapter 3. Arsenic dusts are also a very serious source of poisoning, since so many minerals and ores contain arsenic compounds, sometimes only in traces.

**Arsine ( $\text{AsH}_3$ ).** is an especially dangerous compound, for it may form wherever hydrogen is produced in the presence of arsenic compounds. Arsine gives severe headache, difficulty in breathing, dizziness, cramps, fainting, nausea, and vomiting, the mucous membranes may be bluish and the urine dark. Later anemia and jaundice appear. Exposure of 60 minutes to 5 to 15 ppm (0.02–0.05 mg. / liter, 0.02 to 0.05 avoirdupois oz. / 1000 cu. ft.) may produce serious illness; working conditions at concentrations many times smaller than 3 ppm. will produce symptoms, because the poison accumulates in the body. The maximum allowable working concentration is 0.05 ppm.

**Benzene ( $\text{C}_6\text{H}_6$ ),** benzol, or cyclohexatriene is a clear, colorless, oily, and very inflammable liquid obtained from the distillation of coal tar, and widely used as a solvent and raw material in many organic chemical industries. (The name benzene is often confused with that of the petroleum product benzine, which is described below.) Serious illness due to benzene is caused by an hour exposure of 5000 ppm. (16 mg. / liter; 16 oz. / 1000 cu. ft.). Benzene is a dangerous solvent, the maximum allowable concentration is 25 ppm.

**Symptoms.** Chronic poisoning is indicated by headaches, dizziness, fatigue, ringing ears, heartburn, diarrhea, weak pulse, and a burning sensation in eyes, nose, and mouth. Chronic poisoning is likely to occur if the particular industry carries out evaporation of benzene with improper ventilation, as is likely during the winter months; young girls and pregnant women are especially susceptible.

Acute poisoning is more likely to occur from leaky valves or joints in those industries where benzene is kept in closed pipes. In addition to the symptoms accompanying chronic poisoning, there is fear of death, impaired vision, cyanosis, convulsions, and collapse; death may occur hours to days following exposure.

*Treatment.* A stimulant such as hot coffee or tea may be given. Keep the patient warm and quiet.

Benzine (approximately  $C_8H_{18}$  to  $C_{10}H_{22}$ ) is obtained during the fractional distillation of petroleum; it is the fraction that comes off between  $110^\circ$  and  $150^\circ$  C. Benzine causes headache, dizziness, and irritation of the skin and mucous membranes. Sixty minutes' exposure to 7500 ppm. (about 40 mg. / liter; about 40 oz. / 1000 cu.ft.) may cause death; and working conditions should contain under 2000 ppm. Do not confuse benzine with benzene, discussed above.

Beryllium is a light metal, even lighter than aluminum, that is used in alloys, x-ray apparatus and for nuclear energy purposes. Years ago it was thought that beryllium and its compounds were relatively non-toxic. It is now known that the inhalation of beryllium compounds causes a pulmonary disease. In a sense, illness attributable to beryllium may rightfully be called a disease of the atomic age.

*Symptoms.* Difficulty in breathing, chest pain, cyanosis, coughing, pneumonia.

*Treatment.* Complete rest in bed. For cyanosis, administer oxygen (40-60%). The use of aurintricarboxylic acid has been suggested as an antidote. Beryllium forms complexes with this substance which are nontoxic.

Bromine ( $Br_2$ ) is a heavy, dark, reddish-brown, fuming, obnoxious ("brōmos" means stench in Greek) liquid used for brominating organic chemicals, for making silver bromide in photography, and for producing ethylene dibromide in enormous tonnages, this latter is added to leaded gasoline to react with and prevent free lead from pitting the cylinders of the motor car. Bromine resembles chlorine in its action on the lungs. Sixty-minute exposure to 40 ppm. (0.022 mg. / liter; 0.022 oz. / 1000 cu. ft.) may cause death; 1 ppm. can be tolerated for several hours; and 3.5 ppm. can be detected by its odor.

Butane ( $C_4H_{10}$ ) is a gaseous hydrocarbon used as a low-temperature solvent, in making synthetic rubber, and in "bottled gas" along with other hydrocarbon gases for household cooking. It resembles methane in hazard properties.

Butyl Acetate, normal ( $CH_3COO-C_4H_9$ ) is a colorless liquid used in making safety-glass, plastics, artificial leather, lacquers, photographic film, etc. Concentrations well below the explosive and poisonous limits smell badly enough and irritate the mucous membranes

sufficiently to give ample warning. Guinea pigs were slightly injured from exposure to 7000 ppm. (37 mg. / liter; 37 oz. / 1000 cu. ft.), but could tolerate 3300 ppm. for several hours. The maximum allowable working limit is 200 ppm.

**Butyl Formate** is described under **Amyl Formate**.

**Cadmium (Cd)** is used in welding, plating, low-melting alloys, dental amalgams, etc.; and in cadmium pigments and compounds. It resembles arsenic or mercury in poisonous action. One milligram in 10 cubic meters of air is the permissible limit for factory air. Cadmium fumes and dust cause fatal pneumonia. See Chapters 3 and 4.

**Carbolic Acid.** See **Phenol** in Chapter 3.

**Carbon Dioxide.** See Chapter 3.

**Carbon Disulfide (CS<sub>2</sub>)** or carbon bisulfide, used in many industries as a solvent, for manufacturing viscose rayon, in rubber, insecticides, soil disinfectants, etc., is a colorless or yellowish, vile-smelling, very inflammable liquid. As in most cases of industrial poisoning, chronic poisoning from the vapors is the chief danger. Exposure to about 1000 ppm (3 mg. / liter; 3 avoirdupois oz. / 1000 cu. ft.) may severely poison; workroom concentration should preferably be under 3 ppm. The maximum allowable concentration for an 8-hour working day is 20 ppm.

*Symptoms.* Mild chronic poisoning causes giddiness and symptoms not unlike those caused by chloroform; acute poisoning acts on the nervous system causing temporary or permanent mental disturbances, affected vision, paralysis, also nausea and vomiting, pallor, and weak pulse.

*Treatment.* Summon a physician at once. Remove to fresh air; give a stimulant such as hot coffee or tea, keep the patient warm and quiet.

**Carbon Monoxide (CO).** See also Chapter 3. The great majority of asphyxia cases result from the inhalation of carbon monoxide gas. This deadly, odorless gas is known by several aliases, rightfully deserved, among them being, "perfect killer," "death gas," "invisible death," "creeping killer," and "Death's agent."

Carbon monoxide is very common, and can be found wherever there are appliances that burn coal, coke, gas, oil, or wood. It is found as a result of half-burning or incomplete combustion of carbonaceous materials, as in automobile and engine exhausts, in the celluloid industry, in mines after blasting, where metals are poured, where coal

tar is distilled, where gas-heated irons are used; in the home, where wood, coal, gas, or oil is not completely burned; in industries where there are leakages in blast furnaces; and in other places too numerous to mention.

The hemoglobin of the blood has about three hundred times as great an affinity or attraction for carbon monoxide as it has for oxygen. Since the air we breathe contains about 21% of oxygen, the presence in the air of only one three-hundredth of that amount of carbon monoxide, or about 0.07% is sufficient, when breathed over an extended period, to saturate 50% of the blood hemoglobin and remove it from circulation in so far as its oxygen-carrying ability is concerned. The absorption of carbon monoxide by the blood increases with physical exertion, due to the increased rate and depth of respiration. Carbon monoxide is about 8 times more toxic in the presence of carbon dioxide and water vapor. Carbon dioxide affects the respiratory center, causing an increase in the rate of breathing. Hence, as mentioned, the greater the increase in the rate of breathing the more carboxyhemoglobin is formed and the less hemoglobin is available to transport oxygen as oxyhemoglobin.

Persons having physical defects such as asthma, obesity, bronchitis, or chronic heart or vascular diseases are more susceptible to the effects of carbon monoxide. Sex is apparently not a factor in susceptibility. Where there are two persons, one larger than the other, or where there is an adult and a child, the smaller person absorbs the gas more rapidly and tends to develop the symptoms more quickly.

The blood of a person at rest may become nearly one third saturated with carbon monoxide without causing appreciable symptoms; whereas if he uses any considerable muscular effort, the hemoglobin remaining free from carbon monoxide is not sufficient to transport the oxygen needed, and he may collapse. When his blood is more than half-saturated, a person may collapse, even though at rest. If the victim remains in this condition for any time, the brain and other organs are injured by the continued lack of oxygen, and unconsciousness results.

Dangerous exposure for 60 minutes is 0.15% or 1500 ppm.; the maximum allowable concentration for an 8-hour working day is 0.01% or 100 ppm.

*Symptoms.* Carbon monoxide poisoning occurs in two stages. In the first stage there may be a tightness across the forehead; headache,



throbbing at the temples, dizziness, weakness, weariness, nausea and vomiting, loss of muscular control, increased pulse and respiration, collapse, and finally unconsciousness. When the concentration of carbon monoxide is high or when the victim is at rest, unconsciousness may result without any of these warning symptoms. In the second stage, the blood pressure falls, muscular control is lost, reflexes are dulled, intermittent convulsions may occur, the person's breathing grows shallower, slower, and finally stops.

The effects of various concentrations of carbon monoxide are shown by the following.

<i>Per cent of CO in air</i>	<i>Poisonous effects in one hour</i>
0.01	None [maximum working concentration 8 hour day]
0.04	Negligible
0.10	Unpleasant, not dangerous
0.15	Dangerous
0.40	Fatal

*Treatment.* Carbon monoxide is eliminated through the lungs when fresh air is inhaled. Therefore the treatment is based on the elimination of the carbon monoxide from the blood. The process of elimination can be greatly increased by supplying oxygen to the lungs. This is accomplished by the inhalation of a mixture of 95% oxygen and 5% carbon dioxide. This process will remove carbon monoxide from the body many times faster than normal breathing. If the victim ceases to breathe, artificial respiration should be started immediately. The circulation can be aided by keeping the victim warm with blankets and properly wrapped heat applications. Before applying the heat applications (hot water bottles, chemical heat pads, etc.) they should be tested against the cheek or back of the hand to be reasonably sure they will not burn the patient. Complete rest is essential.

*A gas as deadly as carbon monoxide should never be underestimated.*

Carbon Oxydisulfide (COS) is a colorless, practically odorless gas. Rabbits were seriously injured from 60 minutes' exposure to 32 ppm.

Carbon Tetrachloride (CCl<sub>4</sub>) or tetrachloromethane (see Chapter 3) is a heavy, noninflammable liquid used mainly as a solvent for fats and oils; in textile soaps, rubber cements; as a dry cleaner; and in fire

extinguishers. This last property of course makes it a useful solvent wherever there is any fire hazard. The principal danger is from inhaling vapors of carbon tetrachloride; although when it is used as a fire extinguisher there is also the hazard from its thermal decomposition to form deadly phosgene gas; for this reason carbon tetrachloride extinguishers should not be used in confined spaces. Carbon tetrachloride is one of the more toxic solvents. The maximum allowable concentration is 25 ppm.

*Symptoms.* Nausea and vomiting, eye irritation, headache, pallor and weak pulse. More advanced stages experience abdominal pains and jaundice.

*Treatment.* Summon a physician without delay. Remove to fresh air; give hot coffee or tea as stimulant; keep the patient warm and quiet. Do not give alcohol.

**Chlorine ( $\text{Cl}_2$ ).** See also pages 67-8. Chlorine is a greenish-yellow gas at normal temperatures, and a liquid under pressure. Its use is so widespread that it is transported in tank cars.

The effects of leakage from only one commercial tank of chlorine can be shown by an incident that occurred in Brooklyn, New York, on June 1, 1944. The results were felt principally in the subway station, into which the poisonous gas poured through a ventilator in the street. Passengers leaving the subway cars dropped in their tracks, some were knocked out, and others coughed and were deathly sick. Those receiving only slight poisoning were given first aid and taken home; others were hospitalized. In all, about one thousand were affected, and of this number about half received emergency treatment in some way or other. However, no deaths were recorded.

One widespread use of chlorine is for water purification; and it is with this in mind that this section is included on precautions in its use and handling. When proper precautions are taken, chlorine can be handled with a reasonable amount of safety. Only because manufacturers and users have insisted upon certain safety fundamentals have accidents been kept at a low level.

To minimize danger if accidents do occur, the following suggestions are made: (1) Chlorine should be transported in trucks especially constructed for its transportation, and outfitted with a hose that can be connected to a hydrant. (2) Authorities are to be notified before a truck passes through a municipality; and the truck is to be properly

marked as to its contents, with a sign on each side. (3) When the chlorine is used locally, names and telephone numbers of at least two physicians should be listed and posted where they are convenient for immediate use in the event of an accident. (4) A gas mask, of the best type available, should be provided for those whose duty requires them to expose themselves to chlorine in the event of an accident. This mask must be fitted properly to the individual for whom it is intended, and should be inspected often and kept in proper working condition. A mask not properly fitted or in need of repair is worse than no mask at all. Extra masks should be available in the event that they are needed. Those persons whose duty it is to use these masks must be drilled in their use. (5) At the time of an accident, note the direction of the wind and go upwind, so as to avoid a heavy concentration of the gas. Instruct persons leaving the gassed area to hold wet clothes to their mouths; these greatly decrease the chlorine inhaled. (6) A safety line is to be attached to the man making repairs to chlorine apparatus; this line should run to a fellow worker outside the room or building, so that it can be easily followed if assistance is required.

It is fortunate that chlorine has an irritating odor and will give ample warning of its presence if there is a sudden leak, as from a tank.

Sixty minutes of 35 ppm. (0.1 mg. / liter; 0.1 avoirdupois oz. / 1000 cu. ft.) produces serious injury, but the odor is detectable even at 3.5 ppm. However, it is unsafe to work for many hours in an atmosphere that contains more than 0.1 ppm. The maximum allowable concentration is 1 ppm.

*Symptoms and Treatment.* See Chapter 3, page 68.

Chlorobenzene ( $C_6H_5Cl$ ), benzene chloride, phenyl chloride, or monochlorobenzene is an inflammable, colorless solvent for resins, acetate rayon, lacquers, etc.; it is also a dry cleaner. It is about as toxic as benzene. The maximum allowable working concentration is 75 ppm.

Chlorodiphenyls, a series of waxy solids containing from one to ten chlorine atoms in the molecule, are used for insulating electric wires, condensers, etc. against heat and moisture. A small percentage of persons die every year of yellow atrophy of the liver attributed to it. Working conditions having more than 0.001 mg. / liter (0.001 avoirdupois oz. / 1000 cu. ft.) may produce dermatitis and cause a fatty de-

generation of the liver which may continue on to yellow atrophy of the liver. The threshold working limit is 1 milligram per cubic meter.

**Chloroform.** See page 69.

Chloronaphthalenes are similar to chlorodiphenyls in use and action, but only about half as toxic.

**Chloropicrin** ( $\text{CCl}_3\text{NO}_2$ ), nitrochloroform, or trichloronitromethane, is a colorless liquid with a sharp sweetish odor resembling licorice; it causes tears to flow freely. Chloropicrin is used commercially to exterminate rats and vermin, to disinfect cereals and grain, and to sterilize soil; large quantities were used as a soil fumigant by Hawaiian pineapple growers. Used as a war gas, the British name "vomiting gas" and the nickname "puke stuff," for the American chemical warfare symbol (PS), indicate its physiological action.

**Symptoms.** Dangerous symptoms may be delayed for several hours after exposure. Other symptoms are nausea and vomiting, diarrhea, cramps, pallor. Chloropicrin is a dangerous lachrymator and lung injurant. A concentration of 60 ppm. (0.4 mg. / liter; 0.4 avoirdupois oz. / 1000 cu. ft.) will kill within an hour.

**Chloroprene** ( $\text{CH}_2=\text{CCl}-\text{CH}=\text{CH}_2$ ) or 2-chloro-1,3-butadiene is a colorless liquid from which a type of synthetic rubber (such as neoprene, buna N) is made. Chloroprene lowers the blood pressure, induces detectable changes in the urine, and causes indigestion, and congestion in the throat. Illness may result from 200 ppm. (0.73 mg. / liter; 0.73 avoirdupois oz. / 1000 cu. ft.).

**Chromium (Cr)** is found as chromic acid spray in chromium plating baths. "Chrome holes" (ulcers) are formed. Probable safe working concentration of chromic acid is 0.0001 mg. / liter (0.0001 avoirdupois oz. / 1000 cu. ft.).

**Copper (Cu).** Poisoning from copper salts is common; see Chapter 3. Poisoning from fumes of the metal is rare since the boiling point is so high ( $2310^\circ\text{C}$ ).

**Cresols.** See pages 72-4.

**Cyanogen** ( $\text{C}_2\text{N}_2$ ) is found in coal gas, and with hydrogen cyanide, resembling the latter in poisonous qualities. See pages 39-41.

**Cyclohexane** [ $\text{CH}_2(\text{CH}_2)_4\text{CH}_2$ ], benzene hexahydride, hexahydrobenzene, or hexamethylene is a colorless solvent for rubber, paints, and resins, and also a degreasing agent. Reactions are similar to but less

severe than benzene poisoning. Lethal concentrations are about 18,000 ppm. (60 mg. / liter; 60 avoirdupois oz. / 1000 cu. ft.).

Cyclohexanol [ $\text{CH}_2(\text{CH}_2)_4\text{CHOH}$ ], hexalin, hexahydrophenol, or hydrophenol, colorless liquid or hygroscopic needlelike crystals with an odor like camphor, is used for stabilizing emulsions in detergents, shoe cream, rubber, etc.; in insecticides, textile finishing; and as a rubber and nitrocellulose solvent. Although it paralyzes the nerves, its low volatility renders it less dangerous than benzene.

Cyclohexanone [ $\text{CH}_2(\text{CH}_2)_4\text{CO}$ ], ketohexamethylene, or pimelin ketone, a colorless liquid with a peppermint odor, is a solvent for cellulose plastics, dyes, fats, etc.

Decalin ( $\text{C}_{10}\text{H}_{18}$ ), dekahydronaphthalene, dekalin, or naphthane is a commercial solvent for resins; in varnishes and lacquers; as a fuel; and in dry cleaning. Some investigators have claimed it is nontoxic, while others report dermatitis and systemic poisoning from it.

Diamyl Phthalate and Dibutyl Phthalate are described under Amyl Phthalate.

Dichlorobenzene, ortho- ( $\text{C}_6\text{H}_4\text{Cl}_2$ ), a colorless, inflammable solvent for waxes in lacquers and varnishes, is also used in manufacturing dyes, in fumigating, in destroying termites, in desulfurizing illuminating gas, and in preserving plants. It is about as toxic as carbon tetrachloride. A limit of 50 ppm. has been set as the allowable working concentration.

Dichlorobenzene, para- ( $\text{C}_6\text{H}_4\text{Cl}_2$ ) is a white crystalline solid, widely sold as a moth repellent. It is also used in dog-itch ointment; to kill lice, vermin, peach-tree borers, roaches, etc. It resembles ortho-dichlorobenzene in physiological action; but the para compound, being a solid, does not vaporize sufficiently to be dangerously poisonous.

Dichlorodifluoromethane ( $\text{CCl}_2\text{F}_2$ ) is a colorless, noninflammable, nonexplosive, nontoxic gas. Trade names: Freon, F-12, Kinetic No. 12. Dichlorotetrafluoroethane ( $\text{CCl}_2\text{F}_4$ ) is a nontoxic liquid; trade name F-11. The poisonous member of this group is Trichlorofluoromethane ( $\text{CCl}_3\text{F}$ ), a colorless gas; trade name F-114. Two hours' exposure to 100,000 ppm. (10%) caused guinea pigs to lose coordination.

Dichloroethyl Ether, symmetrical [ $(\text{ClC}_2\text{H}_4)_2\text{O}$ ] or  $\beta$ ,  $\beta'$ -dichloroethyl ether is a colorless solvent used to remove naphthenic components from lubricating oils; also as a solvent for fats, resins, etc.; as a high-

temperature dry cleaner; for scouring textiles; and as a soil fumigant and insecticide. Because it stimulates excessive lachrymation, acute poisoning is unlikely; however, if it is breathed in very low concentrations for long periods, serious irritation of the respiratory system results. An hour's exposure to 500 ppm. (2.2 mg. / liter; 2.2 avoirdupois oz. / 1000 cu. ft.) seriously injures; 35 ppm. gives slight symptoms after 8 hours. The maximum allowable working limit is 15 ppm.

Dichloromethyl Ether, symmetrical  $[(\text{ClCH}_2)_2\text{O}]$  is a colorless, suffocating liquid used as a solvent. It is also a war gas, producing dizziness and staggering; 3 ppm. (0.014 mg. / liter; 0.014 avoirdupois oz. / 1000 cu. ft.) irritates distinctly; 100 ppm. will kill in a few minutes.

Diethylene Glycol  $[(\text{HOC}_2\text{H}_4)_2\text{O}]$  or  $\beta$ ,  $\beta'$ -dihydroxydiethyl ether is colorless solvent for vat dyes, a plasticizer, and intermediate for manufacturing resins and esters; it is also used as an antifreeze solution in refrigerator systems and as a finishing agent for textiles. Because it is sweet and hygroscopic it is also used for moistening tobacco. Over seventy persons were killed in 1937 from taking "Elixir Sulfanilamide" in which diethylene glycol was the solvent. It caused stoppage of urine, intense cramps, nausea and vomiting, stupor, and death. Seven cc. given orally will kill a rat weighing a pound.

Diethylene Glycol Monoethyl Ether  $(\text{HO}-\text{C}_2\text{H}_4-\text{O}-\text{C}_2\text{H}_4-\text{OC}_2\text{H}_5)$  is a slightly hygroscopic, colorless solvent for plastics, dyes, and oil; also for plasticizers as in safety-glass plastic. It is less toxic than ethylene glycol.

Dimethylhydrazine  $[(\text{CH}_3)_2\text{N}_2\text{H}_2]$ , DMH, is a relatively new industrial chemical. It has a distinctly disagreeable odor so that it gives some warning of its presence. Because it is new, not all of its toxic properties are known; but it is caustic to the skin and has caused corneal damage to the eye. It is readily absorbed through the skin.

*Symptoms.* Irritation of the skin and mucous membranes. Marked irritation of the eyes. If inhaled, irritation of the throat and respiratory tract.

*Treatment.* If dimethylhydrazine is ingested, give an emetic of the soapy solution type or use 5% salt solution. Wash the stomach thoroughly.

*Eye Treatment.* Use copious amounts of water to wash out the eye. The patient should be sent to an ophthalmologist immediately who

should be informed to treat the eye as if the toxic material were ammonia.

*External Treatment.* Dimethylhydrazine must be washed away from the contaminated portion of the skin. Remove all contaminated clothing and shower the body for 15 minutes. After washing the exposed skin, treat with a soothing ointment as if it were a burn.

Dimethyl Sulfate  $[(CH_3)_2SO_4]$  or methyl sulfate, a colorless, oily liquid with an onion odor, is an important methylating agent. Even the vapor is a dangerous lachrymator and vesicant, and a war poison gas; it is as toxic as phosgene. An hour's exposure to 20 ppm. (0.1 mg. / liter; 0.1 avoirdupois oz. / 1000 cu. ft.) kills. Flushing the skin with hot water or alkalis destroys the substance.

Dinitrochlorobenzene  $[ClC_6H_3(NO_2)_2]$ , 2,4-dinitrochlorobenzene, or 4-chloro-1,3-dinitrobenzene, yellow crystals used in the dye industry and for detecting nicotinic acid and other pyridine derivatives, is a powerful skin irritant. The dust is definitely more poisonous than nitrochlorobenzene.

Dinitrophenol, alpha  $[HOC_6H_3(NO_2)_2]$  or 2,4-dinitrophenol forms yellow rhombohedrons that are an explosive and dyestuff intermediate; it is also a pH indicator, and is used in medicines for obesity; it has caused death, producing fever, sweating, rapid, weak pulse, and skin irritation.

Dioxane ( $C_2H_4-O-C_2H_4-O$ ), 1,4-dioxane, or diethylenedioxiide is a ring ether; it is a colorless, mildly pleasant solvent used in the lacquer and plastic industry and as a preservative, fumigant, deodorant, and wetting agent. Authorities disagree as to the exact toxic concentrations, but 5000 ppm. (18 mg. / liter; 18 avoirdupois oz. / 1000 cu. ft.) for an hour produces lachrymation and a burning sensation in the nose and throat. Dioxane may also be absorbed through the skin.

Ethane ( $C_2H_6$ ) is a colorless, gaseous hydrocarbon used in fuels and as a refrigerant. See Methane.

Ether. See Chapter 3.

Ethyl Acetate ( $CH_3COO-C_2H_5$ ), acetic ether, or vinegar naphtha, a colorless liquid possessing an odor of apples, is used in manufacturing other fruit flavorings and perfumes, and as a solvent and intermediate in preparing plastics, explosives, lacquers, etc. Ethyl acetate is

not especially poisonous, although high concentrations or continued exposure may irritate the nose, throat, or skin, or even have a narcotic effect.

Ethylbenzene ( $C_6H_5-C_2H_5$ ) or phenylethane, a colorless, pungent, inflammable, irritating liquid, is used as an antiknock in airplane fuels, and for preparing certain sterols. Because of its irritating effect, a human being could not remain in a dangerously high concentration; guinea pigs were killed by an hour's exposure to 10,000 ppm. (40 mg. / liter; 40 avoirdupois oz. / 1000 cu. ft.), which caused them first to become dizzy, unconscious, gasping, and trembling.

Ethyl Bromide ( $C_2H_5Br$ ), bromoethane, monobromoethane, bromic ether, or hydrobromic ether, a colorless solvent, refrigerant, anesthetic, and ethylating agent, forms explosive and inflammable mixtures with air. Action is similar to that as methyl chloride. An hour's exposure to 10,000 ppm. (45 mg. / liter; 45 avoirdupois oz. / 1000 cu. ft.) caused severe damage to animals; about 2000 ppm. for several hours did not injure.

Ethyl Chloride ( $C_2H_5Cl$ ) or chloroethane, a highly inflammable gas used in refrigeration and as a local anesthetic. Although it resembles methyl chloride in physiological effects, ethyl chloride does not irritate the lungs so much; for this reason a person may unwittingly become dangerously exposed to ethyl chloride.

Ethylene ( $C_2H_4$ ) an unsaturated hydrocarbon present in illuminating and petroleum gases artificially ripens fruits and bleaches vegetables. Although it is anesthetic in sufficiently large quantities, the chief hazard is that of fire and explosion.

Ethylene Dibromide [ $(CH_2Br)_2$ ], a colorless, heavy liquid used in some fire extinguishers, exceeds chloroform in narcotic action and resembles it in odor. It is an important ingredient of ethyl fluid and ethyl gasoline.

Ethylene Dichloride [ $(CH_2Cl)_2$ ], 1,2-dichloroethane, or Dutch liquid is a very stable solvent. It is finding increased use for dipped rubber goods, edible oils, and fats. Its chloroform-like odor and the irritation it causes in the nose and eyes are protection against poisoning. Exposure to 4000 ppm. (12 mg. / liter; 12 avoirdupois oz. / 1000 cu. ft.) for an hour produces serious illness; the maximum allowable concentration for an 8-hour working day is 100 ppm.

*Symptoms.* Nausea and vomiting; headache; irritation of the eyes,



nose, and throat; pallor; weak pulse, subnormal temperature; dizziness; partial paralysis; and unconsciousness.

*Treatment.* Summon a physician immediately. Remove the patient to fresh air; give a stimulant such as hot coffee or tea; keep the patient warm and quiet.

Ethylene Glycol  $[(\text{CH}_2\text{OH})_2]$  or glycol is a syrupy solvent used as an antifreeze and explosive intermediate, textile dye and finish, gas meter lubricant, and in phthalate resins. Its hygroscopic nature adapts it as a moistener for tobacco. See Chapter 3.

Ethylene Glycol Dinitrate  $[(\text{CH}_2-\text{ONO}_2)_2]$  is a yellow liquid that is an explosives intermediate. It explodes at about  $115^\circ\text{C}$ . In toxic effects it resembles nitroglycerin, but may appear more toxic because it is more volatile.

Ethylene Glycol Monoethyl Ether  $(\text{HOCH}_2-\text{CH}_2\text{OC}_2\text{H}_5)$  Cellosolve, 2-ethoxyethanol, is a colorless plastics solvent and lacquer thinner. It is a solvent of moderate toxicity. See Ethylene Glycol in Chapter 3 for symptoms of acute poisoning and treatment. The threshold limit is 200 ppm. Continued exposure to low concentrations may cause chronic poisoning.

Ethylene Glycol Monomethyl Ether  $(\text{HOCH}_2-\text{CH}_2\text{OCH}_3)$  methyl Cellosolve, 2-methoxyethanol is a faint-smelling solvent for cellulose acetate and nitrate plastics, lacquers, and dopes; it is used in dye baths, as a stabilizer for emulsions, and in "Jaysonizing" to prepare stiff shirt cuffs and collars. Working conditions in which there is more than 25 ppm. (0.07 mg. / liter; 0.07 avoirdupois oz. / 1000 cu. ft.) may poison the blood. It is more toxic than the ethyl homologue discussed above.

Ethylene Oxide  $(\text{CH}_2-\text{CH}_2-\text{O})$ , a ring compound and colorless gas, is a liquid below  $12^\circ\text{C}$ . It is used as a fumigant for foodstuffs and textiles. Allowable concentrations warn by irritating the eyes and nose, great exposures produce nose bleeds, intoxication, gasping, and death. Guinea pigs were seriously injured by 3000 ppm. (51 mg. / liter; 54 avoirdupois oz. / 1000 cu. ft.) but tolerated 250 ppm. for several hours.

Ethyl Ether. See Chapter 3.

Ethyl Formate is described under Amyl Formate.

Ethyl Silicate, ortho-  $[(\text{C}_2\text{H}_5)_4\text{SiO}_4]$  or tetraethyl orthosilicate, a colorless, pungent, inflammable liquid, is a binding material and

hardening agent, in waterproof cements and ceramics. Concentration of 85 ppm. can be smelled; and 700 ppm. (6 mg. / liter; 6 avoirdupois oz. / 1000 cu. ft.) irritates the eyes and nose; this concentration is dangerous for a 30 minute exposure.

Formaldehyde. See Chapter 3.

Gasoline. See Chapter 3.

Hydrogen Selenide ( $H_2Se$ ) corresponds in properties and toxicity to Hydrogen Sulfide (see Chapter 3). Animals exposed to 6 ppm. (0.02 mg. / liter; 0.02 avoirdupois oz. / 1000 cu. ft.) for 1 hour died within 25 days.

Hydrogen Sulfide. See Chapter 3.

Hydroquinone [ $C_6H_4(OH)_2$ ], *p*-hydroxybenzene, hydroquinol, or quinol forms colorless crystals used in an old type photographic developer. The dust irritates the skin of workers, and discolors the eyes. See Resorcinol, Pyrocatechol.

Iron (Fe) is not harmful. But iron carbonyl is poisonous, like nickel carbonyl.

Isopropyl Ether [ $((CH_3)_2CH)_2O$ ] or diisopropyl ether, a colorless solvent with an ethereal, camphorlike odor, is used to improve motor fuel performance. An hour's exposure to 30,000 ppm. (125 mg. / liter; 125 avoirdupois oz. / 1000 cu. ft.) produces intense intoxication or death; less than 10,000 ppm. is assumed to be a safe working concentration for short periods.

Lead (Pb) salts (see Chapter 3) and lead dust are extremely poisonous. Lead compounds may be many times more soluble in the blood than in water: thus lead monoxide is 68 times more soluble; lead carbonate 20 times more soluble; and lead which is practically insoluble in water dissolves to the extent of 578.0 mg. per liter of serum. Lead sulfate is about equally insoluble (44 mg. / liter) in both solvents.

Inhalation of about 2 mg. of lead dust a day will produce lead poisoning in a few years. In other words, minute quantities taken at frequent intervals fail to be excreted rapidly enough from the system, and in time accumulate to a point where the body tolerance is exceeded. Approximately 0.015 ppm. (0.00015 mg. / liter; 0.00015 avoirdupois oz. / 1000 cu. ft.) is generally accepted as the maximum safe concentration in a workroom. According to Jacobs this may be com-

pared with a usual concentration of 0.00001 mg. per liter normally in the atmosphere of industrial establishments, 0.000013 mg. in auto repair shops, and 0.000009 mg. at congested street intersections.

*Symptoms.* Nausea and vomiting, cramps, diarrhea followed by obstinate constipation, metallic taste in the mouth, weakness, pallor, blue lead line on the gums at their junction with the teeth, weak pulse, headaches.

*Treatment.* Give a stimulant such as hot coffee or tea. Keep the body warm and quiet.

Magnesium (Mg) is a silvery white substance, about two-thirds the weight of aluminum. At high temperatures it reacts violently with water, liberating hydrogen; and with carbon dioxide, liberating carbon. Water will therefore not extinguish such a fire, and carbon dioxide extinguishers are useful only if they can chill the burning magnesium below its ignition temperature. Magnesium fires are either slow burning or of the flash type, depending upon the fineness of division of the burning particles (e.g. flashlight powder). The heat from a flash fire is tremendous and severely burns and injures the skin. The dust itself is not a poison hazard.

*Symptoms.* Burning magnesium gives second and third degree burns.

*Treatment.* Relief from shock and pain are probably the most important emergency steps. Most doctors prefer to have the burn left alone, so that they can apply the particular burn application which their experience has proved most satisfactory. If a burn application is to be used, it is suggested that one of the water-soluble type be employed.

Manganese (Mn) is a hard, brittle, lustrous metal. The salts are usually pink. Manganese is of greatest importance for making extremely hard steels as for safes, heavy-duty rails and machinery, rock-crusher jaws, etc. Manganese compounds are used in glass, as manganese resins in paint driers, as black manganese dioxide in electric dry cells, etc. Poisoning results from inhalation of fumes and dusts, but is found only in special industries.

*Symptoms.* Nausea and vomiting, diarrhea, headache, stiffness of the muscles, twitching, pallor, weak pulse, defective speech, affected gait and drowsiness.

Mercury (Hg). See under Mercury in Chapter 3 for mercury salts.

colorless, liquid lachrymator, is admixed with hydrocyanic acid fumigants as a warning agent.

Methylcyclohexanol [ $\text{CH}_3(\text{C}_6\text{H}_{10})\text{OH}$ ], hexahydroresol, or hexahydromethyl phenol is a mild nose and throat irritant, similar to cyclohexanol in properties and uses.

Methylene Chloride ( $\text{CH}_2\text{Cl}_2$ ), dichloromethane, or methylene bichloride, a colorless, noninflammable solvent for fats, rubber, and cellulose acetate, is also used in cleaning fluids and paint removers, and occasionally as a local anesthetic. It is somewhat less toxic than methyl chloride. Do not confuse it with methylene bichloride Eastman, which is a mixture of methyl and ethyl chlorides.

Methyl Ethyl Ketone ( $\text{CH}_3\text{CO}-\text{C}_2\text{H}_5$ ) or butanone, a colorless solvent with a more pleasing odor than acetone, is used in lacquers and paint removers and in the manufacture of colorless resins and smokeless powders. Concentrations sufficiently high to irritate the eyes and nose are neither inflammable nor particularly toxic. Guinea pigs suffered from one hour's exposure to 50,000 ppm. (160 mg. / liter; 160 avoirdupois oz. / 1000 cu. ft.) but tolerated 3000 ppm. for several hours.

Methyl Formate ( $\text{HCOOCH}_3$ ), a colorless, inflammable, liquid with a pleasant odor, is used as a foodstuffs and tobacco larvicide and as a refrigerating liquid. Its odor and mild irritating action warn before any serious poisoning may occur, but the danger of explosion exists unless it is mixed with carbon dioxide. Guinea pigs were injured in 60 minutes by 15,000 ppm. (33 mg. / liter; 33 avoirdupois oz. / 1000 cu. ft.) but tolerated 2000 ppm. for several hours.

Methyl Propyl Ketone ( $\text{CH}_3\text{CO}-\text{C}_3\text{H}_7$ ), ethyl acetone, or 2-pentanone resembles methyl butyl ketone in properties and use, but is slightly less toxic.

Naphtha (approximately  $\text{C}_4\text{H}_{10}$  to  $\text{C}_8\text{H}_{18}$ ) is obtained by the distillation of petroleum. See Petroleum for the boiling points of various fractions. It is highly inflammable, but is used as a solvent, for degreasing and in certain paints and insecticides, and in photography. It should be distinguished from solvent naphtha, a coal-tar product described in the next paragraph. Petroleum naphtha causes headache, dizziness, irritation of the membranes, and dermatitis. One hour's exposure to 7000 ppm. (25 mg. / liter; 25 avoirdupois oz. / 1000 cu. ft.) is dangerous; the safe working concentration is 500 ppm.

Naphtha (Solvent) is a liquid mixture of organic ring compounds of coal-tar origin, in contrast to the naphtha described in the preceding paragraph. Solvent naphtha is a diluent and solvent for lacquers, oils, gums, etc. It contains benzene, xylene, toluene, ethylbenzene, etc., and combines their poisonous properties. The maximum allowable concentration for an 8-hour work day is 200 ppm.

Naphthalene ( $C_{10}H_8$ ). See Chapter 3.

Nickel (Ni) is used in plating. Nickel dust is not especially dangerous. Nickel salts are somewhat less dangerous than the corresponding copper salts. Nickel Carbonyl [ $Ni(CO)_4$ ] or nickel tetracarbonyl is a yellow liquid that explodes at around  $60^\circ C$ . It is used in the Mond process for purifying nickel. It is very poisonous indeed. 60 minutes' exposure to 180 ppm. (2 mg. / liter; 2 avoirdupois oz. / 1000 cu. ft.) killed rabbits. The threshold limit is 0.001 ppm.

Nitrobenzene ( $C_6H_5NO_2$ ), nitrobenzol, essence or oil of mirbane, a yellowish, oily liquid with an odor of oil of bitter almonds (like benzaldehyde), is used to manufacture aniline and in explosives, dyes, and shoe polishes. Absorption through the skin from spilled liquid is harmful; the vapor is even more toxic. Nitrobenzene produces pronounced cyanosis, nausea and vomiting, intoxication, respiratory failure, and coma; it also poisons the nerves, causing tremors, etc. An hour's exposure to 200 ppm. (1.0 mg / liter; 1 avoirdupois oz. / 1000 cu. ft.) may be tolerated without serious injury; working concentrations should definitely be under 1 ppm. Metadinitrobenzene [ $C_6H_4(NO_2)_2$ ], similar to nitrobenzene in toxicity, forms colorless or yellowish rhombohedrons used as an explosives intermediate.

Nitrochlorobenzene, ortho-para mixture ( $ClC_6H_4NO_2$ ) when impure is a liquid; it is used in the manufacture of explosives. Its poisonous effect can be cumulative; it is a blood poison slightly more dangerous than nitrobenzene. Trade name: Tropoel.

Nitrogen Oxides ( $NO$ ;  $NO_2$ ;  $N_2O_3$ ;  $N_2O_4$ ; and  $N_2O_5$ ), so-called nitrous fumes, are a great hazard in a number of chemical industries: the lead chamber process, the manufacture of explosives, photographic film, celluloid, other pyroxylin products, and fertilizers. Nitrogen oxides are dangerous because a lethal dose gives no warning: following unrealized exposure, the worker may succumb the next day. Probably one of the most dangerous conditions arising from its inhalation

is pulmonary edema (developing several hours after exposure), similar to that suffered from chlorine or phosgene poisoning. Many of the deaths from the fire that occurred in the Coconut Grove Club in Boston in 1912 were due to nitrogen oxides that formed. Sixty minutes at a nitric oxide concentration of 100 ppm. (0.12 mg. / liter) can cause illness; 10 ppm. can be safely tolerated for several hours; the maximum allowable concentration of nitrogen oxides (expressed as nitrogen dioxide) is 5 ppm.

*Symptoms.* Choking, coughing, nausea and vomiting, bloody expectoration, weak pulse, pallor, cyanosis, and collapse.

*Treatment.* Summon a physician immediately. Keep the patient warm and quiet (complete rest is very important). It may be necessary while awaiting the physician's arrival to administer oxygen to relieve the cyanosis.

Nitroglycerin [ $C_3H_5O_3(NO_3)_3$ ] or glyceryl trinitrate is a yellow liquid that explodes on being jarred, or at  $260^\circ C$ . When tasted or applied to the skin, it is likely to produce a violent headache. Poisoning is evidenced by a thumping heart, flushed face, intense headache; and at times nausea and vomiting, and unconsciousness.

Spirit of glyceryl trinitrate, or Spirit of Glonoin, or solution of glyceryl trinitrate, is an approximately 1% solution of nitroglycerin in alcohol, used medicinally as a vasodilator. If tasted or applied to the skin, the solution produces a violent headache. **DANGER:** If spirit of glyceryl trinitrate is spilled, immediately add a solution of sodium hydroxide to destroy it chemically; otherwise the alcohol will evaporate, leaving an explosive residue.

Nitrous Oxide ( $N_2O$ ) or laughing gas. See Ether, page 80.

Oxygen ( $O_2$ ) is not a poisonous gas; but it is an explosion hazard, particularly with traces of oil, such as might accidentally be applied to the reducing valves in inhalators and resuscitators.

Ozone ( $O_3$ ) is a colorless gas with a characteristic, bracing odor. It is used industrially as a bleach, for purifying air and water, and for manufacturing potassium permanganate. It is a very dangerous gas and the maximum allowable concentration has been set at 0.1 ppm.

Petroleum is a mixture of several hundred compounds of carbon and hydrogen (hydrocarbons). Distillation yields the following fractions:

Name	Approximate Number of C Atoms	Boiling Point Range, °C	Uses
Gases . . . . .	CH <sub>4</sub> to C <sub>4</sub> H <sub>10</sub>	-162 to +0.5	Fuel, carbon black
Petroleum ether ..	C <sub>4</sub> to C <sub>7</sub>	20 to 60	Solvent
Petroleum benzene.	C <sub>4</sub> to C <sub>6</sub>	40 to 90	Solvent
Petroleum naphtha	C <sub>4</sub> to C <sub>9</sub>	65 to 120	Solvent
Gasoline . . . . .	C <sub>4</sub> to C <sub>12</sub>	40 to 225	Motor fuel
Benzene . . . . .	C <sub>4</sub> to C <sub>10</sub>	110 to 150	Fuel, cleaner
Kerosene . . . . .	C <sub>10</sub> to C <sub>16</sub>	175 to 300	Fuel, lighting
Middle fraction	about 40%		
gas oils . . . . .	crude oil	225 to 375	Cracked into gasoline
Lubricating oils ..	—	350	Lubrication
Paraffin . . . . .	—	Solid	Candles, water proofing
Tar residue . . . . .	—	Solid	Paving, roofing
Coke . . . . .	—	Solid	Fuel

Phenol (C<sub>6</sub>H<sub>5</sub>OH). See Chapter 3.

*p*-Phenylenediamine [C<sub>6</sub>H<sub>4</sub>(NH<sub>2</sub>)<sub>2</sub>], paradiaminobenzene, or Ursol D forms red to white crystals, which darken in the air. It is a photographic developer and fur dye. Numerous cases record its irritating effect on workers in rubber factories, on persons wearing furs dyed with phenylenediamines, and on persons using hair dyes containing this substance as an ingredient. It also severely injures the eyes.

Phosgene (COCl<sub>2</sub>) is a colorless gas formed by thermal decomposition of chlorinated hydrocarbons in dyeworks and other chemical plants. Dangerous quantities may be formed if carbon tetrachloride is used to extinguish fires in small rooms. Note that phosgene contains no phosphorus. The victim may not evidence serious poisoning for several hours after being poisoned.

*Symptoms.* Tightness in the chest region, coughing, headache, often bloody sputum, and bad taste if attempt is made to smoke a cigarette. The tiny sacs in the lungs fill with body fluid, probably mix with hydrochloric acid formed from the hydrolysis of phosgene in the lungs. A 60-minute exposure of 10 ppm. (0.014 mg. / liter; 0.044 avoirdupois oz. / cu. ft.) is dangerous; maximum working concentration is 1 ppm. A concentration of 5.6 ppm. can be smelled, and so gives warning.

*Treatment.* Summon a physician at once. While waiting for the physician to arrive, keep the patient warm and quiet, absolutely quiet, as the slightest exertion may result in the victim's collapse. Do not administer artificial respiration, but oxygen may be given in its place.

Phosphine (PH<sub>3</sub>), not to be confused with phosgene above, is a color-

less, nauseating gas found as an impurity in the manufacture of acetylene from calcium carbide,  $P_4S_3$  for safety matches, phosphorus, and ferrosilicon. Phosphine causes headache, loss of appetite, thirst, and dizziness. Exposure for 60 minutes at 400 ppm. (0.56 mg. / liter; 0.56 avoirdupois oz. / 1000 cu. ft.) may kill; safe working conditions is 0.05 ppm. or under.

**Phosphorus (P).** See Chapter 3.

**Phosphorus Trichloride ( $PCl_3$ )** or phosphorous chloride, is a colorless, pungent liquid, which fumes in the air. It is used for chlorinating organic compounds, and in the manufacture of two other chlorinated products: **Phosphorus Pentachloride ( $PCl_5$ )**, phosphoric chloride, or phosphorus perchloride, deliquescent crystals, and **Phosphorus Oxychloride ( $POCl_3$ )**, or phosphoryl chloride, a colorless, fuming, pungent liquid. All three compounds suffocate, inflame the lungs and passages, and cause lachrymation; the expectoration is bloody. Fifty ppm. (0.3 mg. / liter; 0.3 avoirdupois oz. / 1000 cu. ft.) of  $PCl_3$  for an hour injures seriously; exposure to a concentration of 0.7 ppm. for several hours was found not dangerous.

**Picric Acid [ $HOC_6H_2(NO_3)_3$ ].** See page 96.

**Propane ( $C_3H_8$ )** is a gaseous hydrocarbon found in "bottled gas," and also used as a raw material for a number of organic chemicals, and in case hardening. See Methane.

**Pyridine ( $C_5H_5N$ )** is a colorless to brownish solvent for anhydrous mineral salts, and is also used to manufacture organic compounds. Its repulsive odor suits for use as a denaturant for ethyl alcohol. The vapor causes coughing, irritation of the mucous membranes and eyes; and the liquid irritates the skin. Swallowed, pyridine produces headache, dizziness, drowsiness, and tremor. The maximum allowable concentration is 10 ppm.

**Pyrocatechol [ $C_6H_4(OH)_2$ ]**, catechol, *o*-dihydroxybenzene, pyrocatechin, or pyrocatechuic acid forms white crystals, which turn brownish in the air. It is a photographic developer, hair dye, and analytical reagent. Supersensitive people suffer from skin irritation upon contact with it. See also Resorcinol, and Hydroquinone.

**Radioactive Substances** such as Radium, Uranium-235, Plutonium, Cobalt-60, and related elements and daughters have become relatively common industrial materials along with uranium and thorium com-



pounds. They will become even more widespread as their use for power production and in industry increases. Depending on the type of disintegration, these radionuclides give off alpha, beta, and gamma rays—that is, rays of helium particles, electrons, and powerful electromagnetic waves, respectively. These emanations, particularly the gamma rays, can cause burns both internally and externally. Other symptoms caused internally are ulcers, severe anemia, and bone disorders. In 1958, much greater concern was exhibited with respect to the dangers from such sources, and the permissible limits of exposure were reduced to  $\frac{1}{2}$  of the limits previously permissible. All workers using such products should wear badges and other devices that can be analyzed so that the total amount of radiation to which they have been exposed can be evaluated. See Chapter 7.

Resorcinol [ $C_6H_4(OH)_2$ ], *m*-dihydroxybenzene, or resorcin forms colorless crystals, which turn brownish pink in the air. It is used in tanning, photographic developers, and in the manufacture of dyestuffs, explosives, and other organic chemicals. Persons especially susceptible to resorcinol suffer from skin irritation. See also Hydroquinone and Pyrocatechol.

Selenium (Se) is used in glazes, pigments, alloys, rubber, photo-electric cells, insecticides, to color glass ruby red; as a catalyst for organic reactions; etc. Selenium also occurs as an impurity in many sulfide ores, and is a hazard found in treating these ores—e.g., in electrorefining copper, the metallurgy of silver, and the lead chamber process for sulfuric acid. Garlicy breath is a very characteristic symptom of selenium poisoning; in fact this nonmetal was discovered by Berzelius when his housekeeper complained that he was eating too much horseradish and garlic for lunch, whereas he had actually been working with selenium-bearing copper ores. See also Hydrogen Selenide, above.

Selenium Oxychloride ( $SeOCl_2$ ) is an extremely toxic, corrosive liquid which imparts a garlicky odor to breath and perspiration, and gives a coated tongue. Selenium oxychloride is extremely vesicant, producing third-degree burns on the skin; if spilled it should be rapidly flushed with quantities of water. Only 0.01 cc. applied to the skin of a rabbit killed within a day.

Sewer Gas can be found in sewers, sewage disposal plants, cesspools, and other locations where putrefying organic material is present. This gas is deadly in small concentrations, as it contains poisonous gases

having a high toxicity. Hydrogen sulfide, one of the most important and deadly gases present, has the odor of rotten eggs and a toxicity rating almost as great as cyanide. Where as little as 0.1% concentration is present, immediate unconsciousness results, and unless the victim is removed at once from the contaminated atmosphere and given artificial respiration, death will result.

There is also a deficiency of oxygen in sewer gas, and inflammable gases are present that are capable of exploding. Whenever a leak of sewage occurs in a confined area or space, the hazard of explosion is possible; for this reason flame should be avoided.

A deficiency of oxygen is present because of reactions with other gases and substances and because of displacement by other gases. When this condition arises the victim has a feeling of lightheadedness and weakness before collapse. Under these conditions a self-contained breathing apparatus is required; the canister-type respirator cannot be used when there is a lack of oxygen. One should *never* attempt to rescue a person trapped in a sewer, pit, tank, etc. unless a proper mask is available. Any such foolhardy attempt may only result in two dead people instead of one.

Smokes and Gases from Fire are responsible for many deaths in industrial fires. Approximately 2000 persons are injured or killed each year in such fires; the majority of these deaths result from smoke and gases. Often the gases reach the victims before the flames and heat.

Gases given off by many burning substances are highly toxic and deadly. On May 15, 1929, there were 125 persons killed in the Cleveland Hospital fire. Most of the victims died from inhaling the gases from burning nitrocellulose films: gases that were a mixture of carbon dioxide, pyroligneous acid, carbon monoxide, hydrocyanic acid, nitrogen oxide fumes, etc., the latter particularly in this instance from the burning nitrate film.

The poisoning resulting from smokes and gases from burning wood is primarily due to carbon monoxide. But other factors should also be considered—for instance, the fact that carbon dioxide always present in the fire gases *stimulates respiration and thereby increases the inhalation of other gases.*

Sulfur Monochloride (Chlorinated Sulfur) ( $S_2Cl_2$ ), sulfur chloride, or sulfur subchloride is a reddish-yellow fuming solvent for oils and fats, also used in printers ink, varnishes, cements, as a rubber vulcan-

izer, for hardening wood, and as an insecticide. Thionyl Chloride ( $\text{SOCl}_2$ ) or sulfurous oxychloride is a colorless suffocating, fuming liquid. Sulfuryl Chloride ( $\text{SO}_2\text{Cl}_2$ ) is a colorless, very pungent liquid used for preparing chlorosulfonates; mixed with war gases it forms heavy smoke on contact with the moisture of the air. All three of the above chlorinated sulfur compounds irritate the membranes of the nose, mouth, and particularly the eyes (lachrymators); their poisonous properties are possibly due to their hydrolysis to form sulfur dioxide and hydrochloric acid.

Sulfur Dioxide ( $\text{SO}_2$ ) is used in sulfuric acid manufacture, bleaching as in the fruit and paper industries, refrigeration, fumigation; etc. Sulfur dioxide from smelting sulfide ores and from burning coal containing sulfur compounds pollutes the air in the form of sulfuric acid, to which  $\text{SO}_2$  is converted by oxidation. Symptoms are irritation of the upper respiratory tract, which sometimes causes pneumonia. Because of its sharp, biting odor it gives more warning than some other gases. Sixty minutes' exposure to 500 ppm. (1.3 mg. / liter) is dangerous; safe working concentrations for several hours are less than 5 ppm.

Sulfur Trioxide ( $\text{SO}_3$ ) is a colorless liquid that solidifies into needle-like crystals a little below room temperature. It fumes strongly in the air. Sulfur trioxide, formed in the contact process, is dissolved in dilute sulfuric acid to form concentrated acid, or in still greater concentration to form fuming sulfuric acid (oleum). Ten ppm. of  $\text{SO}_3$  (0.033 mg. / liter) will kill animals in a few minutes.

Tellurium (Te) is used in coloring glass and china; in toning silver prints, to toughen rubber, and to harden lead. It is a brittle, shiny nonmetal. Tellurium fumes affect a person like arsenic. It produces a garliclike odor on the breath; dry, itching skin; metallic taste; nausea, vomiting, and constipation.

Tetrachloroethane. See Acetylene Tetrachloride.

Tetrachloroethylene ( $\text{Cl}_2\text{C}=\text{CCl}_2$ ), carbon dichloride, or perchlorethylene is a colorless, noninflammable liquid with an ethereal odor; it is a commercial degreaser, solvent, and dry cleaner, similar in action to carbon tetrachloride. Tetrachloroethylene causes irritation of the eyes; nausea, vomiting, faintness, dizziness, headache, and visual disturbances.

Tetralin ( $\text{C}_{10}\text{H}_{12}$ ) or tetrahydronaphthalene is a colorless, pungent

solvent for fats, waxes, and oils; it is used for degreasing textiles, and in dry cleaning. Some slight skin irritation and systemic poisoning is claimed from its use.

Thallium (Tl) is present as an impurity in flue dusts in the lead-chamber process; also thallium compounds are used in rat poisons and ant buttons, and in glass. They cause loss of hair, cramps, diarrhea, heart failure, pains in the limbs and severe eye affections.

Tin (Sn) is relatively harmless: guinea pigs tolerated 3 ppm. for months without illness. Tin Tetrachloride ( $\text{SnCl}_4$ ), on the other hand, used for weighting silk and as a mordant in dyeing, may have toxic effect. Tin Salts ( $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ ), tin crystals, or stannous chloride are used as a wool mordant, for weighting silk, and in calico printing.

Toluene ( $\text{C}_6\text{H}_5\text{CH}_3$ ), toluol, methylbenzene, or phenyl methane is a colorless liquid with a characteristic benzenelike odor. It is obtained from coal tar, but lately in huge tonnages by the catalytic cyclicization of petroleum. Toluene is used in manufacturing explosives (TNT) and other organic chemicals; as a solvent, as for extracting active principles from plants; and as a diluent for cellulose esters. Two hundred ppm. toluene is considered the maximum allowable concentration. Toluene causes headaches, vertigo, staggering gait, convulsions, and loss of consciousness.

*o*-Toluidine, ( $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$ ), 2-aminotoluene, 2-methylaniline, or *o*-methylaniline, a light yellow liquid darkening to reddish in the air, is an intermediate in manufacturing dyes, explosives, and other organic chemicals; in printing textiles blue black. Vapors produce headache, weakness, difficult breathing, cyanosis, convulsions, and diarrhea. It is about as toxic as aniline, but is not absorbed so easily through the skin. Some slight injury has been reported from an exposure of several hours at 10 ppm. (0.04 mg. / liter; 0.04 avoirdupois oz. / 1000 cu. ft.).

Trichloroethylene ( $\text{ClCH}-\text{CCl}_2$ ), a colorless solvent with a chloroformlike odor, is used as a degreasing agent and dry cleaner, also in rubber, paints, varnishes, and insecticides. It does not burn at ordinary temperatures but forms phosgene in contact with metals at high temperatures. It is said to be 13 times more active than chloroform as an analgesic. With moisture, trichloroethylene gradually decomposes, acquiring an acid reaction. Experiments on its toxicity to animals give varying results, in general revealing a toxicity about equal to

that of chloroform. A working concentration of under 200 ppm. is the recommended threshold limit.

*Symptoms.* Breathed or absorbed through the skin, it causes nausea and vomiting; headache; sense of confusion; irritation of the eyes, nose, and throat; nervousness; pallor; weakness and weak pulse; unconsciousness and death.

*Treatment.* Summon a physician at once. Remove the patient to fresh air, give a stimulant such as hot coffee or tea, and keep him warm and quiet.

**Tri-*o*-cresyl Phosphate**  $[(CH_3C_6H_4)_3PO_4]$ , or *o*-toluylphosphate is an odorless, yellowish, oily liquid used as a plasticizer for pyroxylin, for varnishes, and in making celluloid. Because of its low volatility, tricresyl phosphate is not especially poisonous, but less than 1 gm. per pound of body weight will cause stomach disorder, then apparent temporary relief, and finally soreness of the muscles and paralysis of the arms and legs. When swallowed it causes "ginger Jake" paralysis.

**Trinitrophenol**  $[HOC_6H_2(NO_2)_3]$ . See Picric Acid, Chapter 3.

**Trinitrotoluene**  $[CH_3C_6H_2(NO_2)_3]$  or TNT is a crystalline explosive which stains the skin and hair of workers a deep yellow. Absorbed through the skin or inhaled, it produces cyanosis, blue "lead line" on the gums, and often jaundice.

**Turpentine** ( $C_{10}H_{16}$ ). See Chapter 3.

**Vanadium (V)** is a metal used in stainless steels, along with chromium. Some vanadium compounds are used in the nonferrous, glass, ceramic, and color industries; and vanadium pentoxide is a catalyst for the sulfuric acid contact process. No cumulative effect of vanadium dust was found, high concentrations produce irritation of the respiratory tract, coughing, hemorrhage, anemia, nausea and vomiting, and later nervousness and dizziness.

**Vinyl Chloride** ( $CH_2=CHCl$ ) or chloroethylene is a colorless gas with an ethereal odor, polymerized in manufacturing vinyl type plastics. It produces loss of locomotion, rapid and later slow breathing, and finally coma. Vinyl chloride is more of a fire hazard than a poison, for the dizziness that it causes is a warning signal. It is less toxic than carbon tetrachloride: 100,000 ppm. of vinyl chloride (256 mg. / liter; 256 avoirdupois oz. / 1000 cu. ft.) for an hour may cause death; 500 ppm. is relatively safe for an eight-hour exposure.

Xylene [ $C_6H_4(CH_3)_2$ ], dimethylbenzene, or xylol is a colorless solvent obtained from coal tar. It is used in manufacturing dyes and organic chemicals; in microscope technique; and for sterilizing catgut. The lower volatility of xylene makes it less dangerous than benzene, but 100 ppm. of xylene (0.43 mg. / liter; 0.43 avoirdupois oz. / 1000 cu. ft.) may produce illness; allowable concentration is 200 ppm.

Zinc (Zn) dust or oxide powder is about as poisonous as other metal dusts but no more so. See Metallic Fumes.

# 6

## POISONING FROM FOODS, PLANTS, SNAKES, AND SPIDERS

### FOOD POISONING

Occasionally people are poisoned by the ingestion of food. Illness and possibly death may result from eating food containing (a) toxins like the exotoxin produced by *Clostridium botulinum* (botulism) or the enterotoxin of staphylococci (the most common type of food poisoning); (b) bacteria, principally *Salmonella*, but also *Proteus*, *Escherichia*, and some *Pseudomonas*; (c) protozoa and parasites, such as *Endamoeba histolytica* (amebiasis), *Trichomonas hominis*, *Giardia lamblia*, and *Gnathostomum mesnili* and *Trichinella spiralis* (trichinosis); (d) poisonous plants such as mushrooms or wheat and rye infected with the fungus causing ergotism; (e) poisonous animals like some mussels; and (f) chemical poisons.

Almost any type of food can become contaminated and thus cause food poisoning, but in particular, certain foods that are good media for bacterial growth and that are often not refrigerated are more commonly associated with such outbreaks. Among these foods are cream puffs, napoleons, custards, cream pies, mayonnaise, salad dressings and other food dressings, macaroni with sauces, bread pudding and stuffings for turkey and other poultry, sausage meat and related products like hash, meat loaf, hamburger, etc., chopped egg, chopped chicken salad, tuna fish salad, and many other foods. It is to be noted that most of such products are chopped or comminuted or passed through mixers. These devices, unless thoroughly cleaned, transfer the bacteria they harbor to the foodstuff, in which they grow when conditions are favorable.

Botulism poisoning may result from the ingestion of underprocessed, nonacid, canned foods such as meats, fish, and legume-type vegetables. Such underprocessing is much more likely to occur in home-canned products than in commercial products, for modern commercial canning procedures make the chance of growth of anaerobic bacteria like clostridia, which produce exotoxins, rare indeed.

From the microbiological point of view one can distinguish between *food infection*, specifically, food poisoning resulting from the ingestion of food contaminated with bacteria (principally *Salmonella*, but also other organisms that cause gastroenteritis) and more generally, the ingestion of food containing pathogenic bacteria, such as those of the enteric group (typhoid and paratyphoid), or those causing tuberculosis from meat and milk, undulant fever from milk, septic sore throat from milk, lumpy jaw, and other diseases; and *food intoxication*, which is food poisoning resulting from the ingestion of food contaminated with toxins, such as the enterotoxin of staphylococci and the exotoxin of *Clostridium botulinum*.

It must be stressed that most cases of food poisoning are of bacterial origin rather than of chemical origin. One of the distinctions between chemical types of food poisoning and food poisoning of bacterial origin is that mass poisonings with chemicals are rare (although not unknown) whereas mass poisonings attributable to bacteria are relatively common. Another difference in bacterial and chemical types of food poisoning is that in the latter the onset of illness is generally much more sudden.

Metals, nonmetallic, and organic contaminants may be present naturally in foods in small amounts and even in poisonous amounts. In addition to the normal amount of metal present in a foodstuff, we may find deleterious quantities of metal or other injurious substances because of

- (1) Their presence as natural components
- (2) The use of insecticides, rodenticides, fungicides, germicides, antiseptics, and other pesticides
- (3) Solution of metal or compound from the utensils or container in which a food is prepared or processed, or stored
- (4) Contact during a manufacturing process, or during fumigation, insect extermination, or cleaning
- (5) Deliberate use for a fraudulent purpose



- (6) Deliberate use as a component in a processing step
- (7) Accident
- (8) Criminal intent

**Poisons as Natural Components of Foods.** Some authorities are reluctant to admit the possibility that some foods naturally contain poisonous quantities of metallic components, for to many the terms "natural" and "pure" are synonymous. They may readily agree to the poisonous compounds contained by mushrooms, rayless goldenrod, etc., but are not so sure of poisonous amounts of metallic contaminants. An excellent example of the presence of toxic amounts of metal in vegetation is the cause of the illness known as "alkali disease." This is a broad term commonly used in the West for a number of disorders which are often associated with an illness caused by the consumption of seleniferous vegetation. The existence of large areas of land containing sufficient selenium to produce toxic vegetation has been demonstrated in the area surrounding the Black Hills, in western Colorado, in portions of the valleys of Uncompahgre, Gunnison, and Colorado rivers, in a portion of western Kansas, and in certain portions of Montana.

Other examples that may be cited are the presence of relatively large amounts of oxalic acid in spinach and rhubarb leaves. The amount of oxalic acid present may range from that sufficient to make the calcium content of these plants nutritionally valueless to toxic amounts. Fatal cases arising from the consumption of almonds and rangoon beans containing excessive amounts of glucosides which yielded cyanides on hydrolysis are further instances of foods naturally containing poisonous amounts of chemicals.

**Use of Insecticides, Fungicides, Germicides, and Rodenticides.** Fruits and vegetables are important to man. They are also important to rats, to insects, to molds, and to other microorganisms. There is an eternal war being waged to see which group will win these materials for food. Fruit, vegetables, and other food products are often protected by rodenticides, insecticides, fungicides, germicides, and antiseptics—chemical substances that kill or inhibit the growth of rats, insects, fungi, bacteria, and other microorganisms. An ideal rodenticide, insecticide, or fungicide would be perfectly harmless to man, would prevent rodent attack, insect infestation, or the attack of other organisms at the proper time, and when that danger was over could be

easily removed, or washed completely away. Unfortunately, killing rodents and insects and preventing the action of other organisms is not a simple matter. Most rodenticides are poisonous to human beings. There are some agents lethal to insects and apparently harmless to man—a harmlessness more often apparent than real. For instance, the insecticide pyrethrum is stated to be harmless to man, but it actually causes allergic conditions in many who use it. There are holders of exterminator permits in the City of New York who refuse to use pyrethrum because of its effect upon their respiratory tract.

Of other agents that are toxic both to insects and to man, some will kill some insects readily and other insects slowly or not at all. The agents which will kill most insects are preferred. Unfortunately these are of types poisonous to human beings. They consist in the main of lead arsenate and copper arsenate. Insecticides and fungicides containing selenium and fluorine are also used. In more recent years the insecticide DDT, dichlorodiphenyltrichloromethane, technically 2,2-bis-(*p*-chlorophenyl)-1,1,1-trichloroethane, has been used on a large scale; but this substance, it has been established, causes toxic effects in human beings, although under proper conditions of use no danger exists. A number of common insecticides have been discussed in Chapter 3.

Spray residue is the insecticide or fungicide that remains on the fruit or vegetable after the rains, washing, and other cleaning processes that the fruit or vegetable undergoes. Toxic effects have been attributed to it.

Often rodenticides and insecticides are the cause of accidental poisonings (see the section "Accident" below).

**Solution of Metal or Compound from Utensils.** Foods may become contaminated by solution of the metal from the utensils in which they are made or from the container in which they are stored. Thus illness has been caused by eating ices prepared in cadmium plated forms, by drinking lemonade prepared in enamelware having anti-mony opacifiers, by eating meat prepared in galvanized iron utensils, etc.

In most instances where a food is badly contaminated by a metal because of solution of that metal, the food is acid in reaction. Some metals, e.g., cadmium, iron, and zinc, are readily soluble in acids, even organic acids. Others e.g., copper, are not. However, some insoluble

metals form compounds which are readily soluble in acid. For instance, copper kettles form a layer of copper carbonate. This compound is easily soluble in weak organic acids.

Enamelware sometimes contains antimony opacifiers. Some of the antimony compounds used for this purpose are more readily soluble than others in acids. Sufficient antimony may actually be dissolved by such an acid as citric or tartaric to cause illness.

Solution may not necessarily take place only in acid media. Alkali will dissolve some metals such as aluminum and zinc. Lead and its compounds are comparatively easily soluble in salts such as ammonium acetate. Very likely there are similar salts in foodstuffs which have this power.

Metals may also dissolve because of local electrolytic effects. This is probably one of the causes for the etching and solution of tin and iron by foods packed in tin cans. The application of lacquer to the tin can inhibits and diminishes this electrochemical effect but does not entirely eliminate it, because the food may have contacts with iron and tin surfaces where minute abrasions in the enamel coating unavoidably expose these metals to the food. The amounts of these metallic salts acquired by the food will depend upon the character of the food. In general, acid foods tend to take up more metal, especially after the can is opened and air can also act on the container.

The amounts of tin and iron salts normally present in commercially canned foods are generally without significance as far as possible hazards to consumer health is concerned.

In one interesting case, some refrigerator units had been replated with cadmium, a metal which is prohibited by the Sanitary Code of the City of New York for use in the manufacture, sale, or keeping of any drink, beverage, or food, any tap, faucet, fountain refrigerator, utensil, vessel, etc. In one of these units a microscopic orifice permitted the refrigerant sulfur dioxide to escape from the expansion coils. The sulfur dioxide dissolved in the surrounding ice and the sulfurous acid formed dissolved the cadmium. This dripped into the water being frozen for ice cubes. When the ice cubes were used for their usual purpose, the people consuming the beverage were made ill.

Another case of interest concerned copper poisoning. In the summer of 1915, four girls employed by a small radio manufacturing company became ill and complained of nausea and vomiting. An investigation disclosed that after taking a soft drink from a dispensing machine at

the plant the four girls developed these symptoms in 5 to 15 minutes.

This machine had two compartments, one for the syrup and the other for the water. The latter compartment was lined with copper. A tank of compressed carbon dioxide gas was part of the unit. Upon the insertion of a coin, there was a flow of water from the water compartment and this was then charged with the carbonic acid of the tank. Simultaneously, some of the syrup flowed into the glass. A valve intended to protect the water compartment from the entrance of carbonic acid gas was found to be defective, and as a result carbon dioxide entered the water compartment. The acid mixture was sufficient to dissolve some of the copper so that the water actually turned a greenish color. A chemical analysis of the water showed the presence of 85 ppm. copper; thus a glass of this drink contained a quantity sufficient to cause toxic symptoms.

**Contact During a Manufacturing Process.** Metals and compounds of a poisonous nature may become incorporated into foods during a manufacturing process, or during fumigation, insect extermination, or cleaning. Solution of the metal in such instances plays the same role as described in the previous section.

In 1937, a suspected food-poisoning outbreak involving several members of a family who had eaten uncooked raisins, among other articles of food, was investigated by the Federal Food and Drug Administration. Suspicion was directed toward the raisins, and a chemical examination of the remaining portion of the package of raisins disclosed approximately 8000 ppm. of hydrocyanic acid.

It was learned that a fumigation had been carried out under emergency conditions on packaged raisins which had been stored for an unusually long period pending settlement of a maritime dispute. The raisins involved in the food poisoning outbreak were part of a very large lot which had been fumigated in this manner. The method of fumigation employed and the amount of hydrocyanic acid used were presumed, on the basis of previous experience, to yield satisfactory results. The suggestion was made that the failure of an atomizing nozzle to function properly resulted in wetting some of the packages with liquid hydrocyanic acid, and that conditions arose which prevented the evaporation of the fumigant which would normally be expected during subsequent aeration.

Cyanides may also contaminate foodstuffs when they are used as

silverware-cleaning polishes. These polishes are generally forbidden but are sometimes used in spite of such prohibitions.

**Deliberate Use for a Fraudulent Purpose.** Poisonous compounds may become incorporated into foods through deliberate use for a fraudulent purpose. The user may not, of course, know that he is using a poison. We may mention the use of lake dyes for coloring foods and aminoazotoluene,  $\text{CH}_3\text{C}_6\text{H}_4\text{N}.\text{NC}_6\text{H}_3(\text{CH}_3)\text{NH}_2$ , as a color for butter (this substance has been shown to have carcinogenetic properties). Other carcinogenetic agents that may sometimes be used are aminoazobenzene,  $\text{C}_6\text{H}_5\text{N}:\text{NC}_6\text{H}_4\text{NH}_2$  (CI 15, aniline yellow), dimethylaminoazobenzene or butter yellow (CI 19, *N,N*-dimethyl-*p*-aminoazobenzene) *N*-methyl-*p*-aminoazobenzene, and 4'-methyl-4-aminoazobenzene (actually CI 19 has been isolated from several food products such as salad dressings and mayonnaise); mineral pigments such as chrome yellow, Prussian blue and ochres, although such use is very rare in these times; potassium aluminum sulfate and similar astringents to give tang to pickles; and copper or zinc salts added to vegetables such as green peas or fruit such as citron to intensify the green color of chlorophyll.

**Deliberate Use as a Component in Processing Step.** Diethylene glycol was once used as a solvent in many artificial fruit flavors. The many deaths attributed to the use of Elixir Sulfanilamide, in which diethylene glycol was used as the solvent for sulfanilamide, brought the dangers of this solvent dramatically to the attention of the country. It was then realized that it was widely used in foods and had even been recommended for such use.

Under this heading we can place the use of chemical preservatives such as formaldehyde, monochloroacetic acid, borates, chlorine, sodium benzoate, salicylic acid, the esters of *p*-hydroxybenzoic acid, and the like. Particular attention should be called to monochloroacetic acid. The use of this material is generally considered illegal, and poisonings have been traced to its use in an orange beverage base. The use of some of these substances is permitted in certain countries when declared. Excessive amounts may, however, cause illness, and they should be kept to a minimum whenever used. Attention should be called to the increasing use of the quaternary ammonium compounds such as the alkylbenzyltrimethyl ammonium chlorides, Roccal, Zephiran, and similar surface active agents. Some of these are considered toxic, and their use in foods will probably be prohibited.

Nitrogen trichloride, a bleaching and maturing agent for flour, apparently causes epileptiform seizures in dogs.

One other example in this category is the improper use of mineral oil as a food ingredient. This material has no food value and causes illness through its deleterious effect on the assimilation of vitamins A, D, K, and carotene.

**Accident.** The contamination of raisins during fumigation, cited above, offers an illustration of accidental commercial contamination. More striking illustrations occur in household contamination. In one instance, a woman mistook a white insecticide powder containing sodium fluoride for flour and used this powder in mixing a batter for potato pancakes. She consumed about eight and died within 24 hours. Two others ate a few of the pancakes and were made ill, but fortunately recovered. Serious cases of fluoride poisoning resulting in death occurred in an asylum in Oregon and in a family in Baltimore.

The City of New York in an attempt to reduce such accidents was the first to introduce the practice of coloring insecticides Nile blue or microcline green.

A case occurred in New York City in which 11 men were made seriously ill as a result of eating oatmeal contaminated with sodium nitrite. Salt shakers had been accidentally refilled with a meat curing composition containing 92 per cent of sodium nitrite. Several salt shakers contained sodium chloride only. Some had faint traces of sodium nitrite. Others contained as much as 0.137 per cent sodium nitrite. Some of the salt shakers probably had been partly filled with the curing compound. The 11 men who became ill unfortunately used the shakers containing large amounts of the nitrite. The ingestion of the nitrite in the shakers plus the nitrite in the oatmeal caused the toxic symptoms.

From time to time instances occur in which persons, often children, become ill or die from the ingestion of a rodenticide like zinc phosphide or sodium fluoroacetate.

**Criminal or Malicious Intent.** Criminal addition, especially of the common poisons, will in some measure simulate the contamination of a food from the sources previously mentioned; hence it is not necessary to dwell longer on this mode of contamination.

**Symptoms of Food Poisoning.** The symptoms may occur promptly in the case of chemical food poisoning or be delayed. Usually the

symptoms are delayed from 3 to 6 hours or even longer in bacterial food poisoning; then they progress in intensity from 12 to 24 hours and subsequently become less intense. Death occurs in only about 1% of the cases. Abdominal pains are usually the first sign and may be griping and severe; nausea and vomiting, diarrhea, headache, chill, faintness, muscular weakness, moderate rise in temperature, restlessness, and skin rashes often occur. In botulinus poisoning there is usually muscle involvement as indicated by double vision, weakness, difficulty in swallowing, and paralysis of the respiratory muscles. Death occurs in about 60% of the cases.

**Treatment.** Summon a physician immediately. Empty the stomach with an emetic such as mustard in water and continue until the evacuated liquid is clear; follow with a large dose of Epsom salts in water but only if diarrhea is not a symptom. Follow with a stimulant such as hot coffee or tea, or aromatic spirits of ammonia (1 teaspoonful in  $\frac{1}{2}$  glass of water) but only 3 to 4 hours after vomiting has ceased. Give no other food for 12 to 24 hours. Keep the patient warm and quiet.

In *botulinus* poisoning, botulinus antitoxin should be administered by the physician not only to the patient but also to every member of the family who has eaten the same food. Give artificial respiration if there is respiratory difficulty and use mechanical methods for dealing with respiratory paralysis.

### POISON IVY—POISON OAK—POISON SUMAC

Poison ivy, poison oak, and poison sumac are all poisonous members of the sumac species (genus *Rhus*). All three cause a severe inflammation of the skin in susceptible persons. Some persons are not poisoned by ordinary handling of the plant, others may be extremely susceptible. No one is completely immune, even though one person may not be so sensitive as others. He may, time after time, handle the plant without a reaction, and then suddenly fall a victim to the poison. The skin reaction is more likely to occur when the skin is wet or damp with perspiration.

Poison Ivy, found in the Eastern States, may grow as a bush, a vine, or a shrub. The leaves are shiny, rather broad, have irregularly cut edges, and are arranged in characteristic groups of three leaves to a stalk; two leaves with short stems are opposite each other on the stalk, and the third leaf is at the end of the stalk.

**Poison Oak**, found in the United States on the Pacific Coast in greater quantity than in the East, grows as a climbing vine as well as in bush form. The leaves are similar to oak leaves and arranged also in groups of three leaves.

**Poison Sumac** is found in the United States mainly along the Atlantic Coast in swamps and wet ground in the form of a shrub or small tree. Other names it is known by are poison elder, poison ash, poison dogwood, and swamp sumac. The leaves are arranged in pairs and opposite each other along a stem, with a single leaf at the end of the stem. The berries, resembling mistletoe, accompanying the plant are in loose clusters from three to eight inches in length and are waxy and cream-colored and remain throughout the winter. The berries of the nonpoisonous sumac are rusty red in color.

**Poisoning from These Plants.** The poisonous substance of each of the three plants causing the skin reaction is oily and related to phenol (carbolic acid). It is found in all parts of the plant and is present in the milky sap. Contamination is caused by handling the plant or any object that has been in contact with it. The evaporation of the poisonous substance is so slow that a person may be poisoned from an object put away months previously. If the plant is being burned, the poison is carried in the smoke, and contact with the smoke will cause poisoning.

The U.S. Public Health Service (Bulletin August 1945) has developed two protective ointments; one is less oily. They contain sodium perborate and oxidizing agents. The ointment is applied generously on the skin where the worker may contact the ivy. The ointment is washed off and new applications made several times during the day. Authorities disagree on the complete success of this ointment.

The poison takes about 15 minutes to penetrate the skin. Poisoning may be prevented if the skin is thoroughly washed with strong laundry soap before absorption occurs. It has been found that first a washing with a solution of trisodium phosphate (Oakite Cleaning Powder, 1 teaspoonful to a quart of water) followed by a thorough soap wash gives better results than just a soap wash.

It is wise to destroy all such plants on your own property by use of weed killers (herbicides) like 2,4-D and its derivatives or Ammate (ammonium sulfamate).

**Symptoms.** Redness, burning, itching, and swelling occur in from





TOP LEFT—POISON IVY (COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY) TOP RIGHT—POISON SUMAC (COURTESY OF BROOKLYN BOTANIC GARDEN) BOTTOM—POISON OAK (COURTESY OF BROOKLYN BOTANIC GARDEN)



UPPER LEFT—RATTLESNAKE. UPPER RIGHT—COPPERHEAD. LOWER LEFT—COTTONMOUTH. LOWER RIGHT—CORAL SNAKE. (COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY.)

a few hours to a few days. Symptoms appear faster in a person allergic to poison ivy than in one not so susceptible. Blisters follow; and larger blisters develop by small ones uniting. A watery fluid is discharged when the blisters are broken; but contrary to general belief, this fluid will not spread the contamination.

**Treatment.** When the area poisoned is large or severe, see a physician immediately. When the rash is first noticed, wash with soap and water and then with a 70% alcohol. Several treatments may be tried for relief:

1. Swab with a 5% ferric chloride solution. If it must be applied near the eyes dilute this solution about one-half. Lemon juice will remove the yellow stain left by this solution.

2. Apply a wet dressing of baking soda and cold water or strong Epsom salts and cold water.

3. Make a thick paste of soap and water and apply on a sterile dressing to the area. Leave on overnight.

4. Large blisters are punctured at the sides with a sterile needle, and the fluid gently pressed out with a sterile dressing or gauze. Apply a dressing soaked in baking soda, or moisten the area with a 5% solution of potassium permanganate.

## POISONOUS SNAKES

There are more than two thousand kinds of snakes in the world; of these somewhat over two hundred species and subspecies inhabit the United States. The weights and sizes of snakes range from a few ounces for those about six inches in length, to more than three hundred pounds for snakes as long as thirty feet. Less than 15% of all snakes possess fangs capable of injecting poison, of which slightly over half will kill human beings. Contrary to general belief, most snakes are actually of value to man, since they feed principally on destructive, obnoxious, and disease-spreading insects and rodents.

Only the poisonous varieties of snakes found in the United States will be considered here. These are easily identified by distinctive markings.

**The Pit Vipers.** (1) *The rattlesnake*; it has a rattle at the end of its tail. (2) *The copperhead*; it is marked with dark saddles, shaped like hour-glasses, across its back. (3) *The cottonmouth water moccasin*; it is dark in color; the top of its head is flat, and the sides of the face

are also flat; where the top joins the sides there is a noticeable ridge running from the tip of the nose to behind the eyes; and the eyes are protected by scales. Nonpoisonous water snakes, on the other hand, do not possess these distinctive features—the flat surfaces, the eye shields, or the ridges.

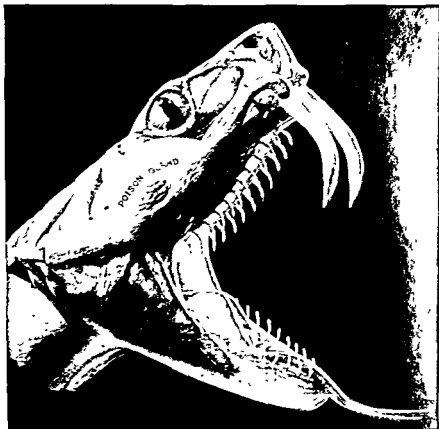
**The Coral Snake.** This snake is found only in the South. It is the smallest of these poisonous snakes, seldom larger than thirty inches in length, with a head not fatter than the body. It has black and red bands, divided by yellow bands, completely encircling the body.

**Snake Bites.** The venom of these snakes is amber-colored; it is produced by the upper salivary glands, and injected into the body by means of two hollow teeth of the upper jaw. These teeth are folded back into the mouth when the mouth is closed, but when the snake bites, the teeth (fangs) are thrust forward. Snake bites, though not common, occur with sufficient frequency to demand care from those who roam the fields, the woods, and the mountains.

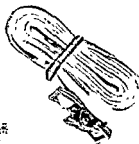
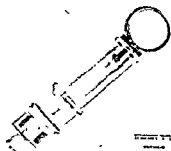
**Symptoms.** A sharp burning pain followed by a discoloration and swelling. As the poison dilutes and passes into surrounding tissues the swelling advances up the limb toward the heart. The arms and legs at times swell to twice their normal size. Two fang marks are sometimes present, although if the bite is imperfect only two scratches may be seen.

**Treatment.** Summon a physician. Use no alcoholic drinks; do not attempt to cauterize the wounds; do not apply potassium permanganate. Apply a constricting band of some type a few inches above the bite to slow down the circulation of the blood. Tighten sufficiently to stop the return of venous blood but not the flow of blood in the arteries. Release every ten minutes for about ten seconds, and then tighten again. Make deep X-shaped cuts  $\frac{1}{2}$  inch long through the skin at the points where the fangs entered the skin. Allow the blood to flow from these cuts, as this will eliminate much of the venom. Apply suction for 20 minutes every hour for several hours. During intervals between suction, cover with sterile dressings which have been wetted with a strong solution of table salt or Epsom salts in water.

**Treatment by the Physician.** The physician may give Antivenin. The North American Anti Snake Bite Serum (L 10A "Lyovac" Anti-venin Nearctic Crotalidae) is supplied with (1) a "Vacule" ampul, containing 15 cc. of restored serum; (2) a syringe containing 15 cc.



HEAD OF POISONOUS SNAKE SHOWING POISON APPARATUS. COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY, N.Y.



**Contents:**

1 Syringe  
1 Roll  
ADHESIVE  
ABSORBENT  
COMPRESS  
WATERPROOF  
THERMAL  
PLASTIC and  
STERILE



DAVIS & CO. INC.  
NEW YORK, N.Y.

1 Roll  
ADHESIVE  
ABSORBENT  
COMPRESS  
WATERPROOF  
THERMAL  
PLASTIC and  
STERILE

**Contents:**

1 Syringe  
1 Roll  
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DAVIS & CO. INC.  
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1 Roll  
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ABSORBENT  
COMPRESS  
WATERPROOF  
THERMAL  
PLASTIC and  
STERILE



DAVIS SNAKE-BITE KIT

of distilled water; (3) a 1 cc. vial of Normal Horse serum (diluted 1:10), as test and desensitizing material; and (4) a first-aid ampul of iodine solution. Sedatives such as aspirin or morphine, or minor doses of a barbiturate, may be given for the relief of pain and nervousness. Aromatic spirits of ammonia or strychnine are of value for collapse. If the individual is severely poisoned, great relief is likely to be experienced from infusion with a large amount of physiological saline or, even better, a transfusion of whole blood. The effects of this treatment may be the difference between life and death.

**L-C Snakebite Treatment.** The L-C snakebite treatment is relatively new. It gets its name from the fact that it involves a ligature (tourniquet) and cryotherapy (use of cold). This treatment has been found effective against the bites of the copperhead, rattlesnake, cottonmouth moccasin, and Gila monster.

The bites of reptiles and lizards are usually on the hands, lower arms, feet, and the lower part of the legs, a fact which makes this treatment easy to apply.

1. Immediately apply a tourniquet just above the bite. A piece of heavy cord or shoestring is advised rather than a wider tourniquet as recommended in the preceding section. Wrap the tourniquet two or three times around the limb, tightening to a point where pain is felt.
2. Place a sizable piece of ice on the bite until a pail of ice and water can be prepared. Chop the ice to pieces smaller than ordinary ice cubes. Every attempt should be made to keep the ice and water in about 50 50 proportion. It will be necessary to dip out some of the water occasionally and replace it with ice. Do not add salt.
3. Submerge the entire affected member in the ice water well beyond the tourniquet. Should the swelling travel beyond the bitten area, submerge past the swollen area.
4. Remove the tourniquet between five and ten minutes (no longer) but continue to keep the limb submerged in ice-water solution. Soak up to six hours.

The venom can be neutralized by the body if it enters the body slowly enough. When the temperature of the bitten arm or leg is reduced from the normal 37°C to 4-7°C, the reaction of the venom is reduced almost entirely.

To produce the required chill, the submersion in ice water is recommended rather than the use of evaporating ethyl chloride, because melting ice will not freeze tissue. Ethyl chloride improperly used can cause frost bite and damage tissue. It must also be remembered that vascular damage is possible from the use of a shoestring or cord tourniquet, but the loss of a hand or foot from the use of a tourniquet or ethyl chloride freezing is not as serious as the loss of a life.

### THE BLACK WIDOW SPIDER

The black widow spider belongs to the arachnid family Theridiidae and has many synonyms, among them "hourglass spider," "shoebutton spider," "Pokomoo," "cul rouge," and many other colloquial names.

The black widow spider in its natural habitat is found in dark locations—in vacant rat holes, under logs and stones, in stumps of trees, and in wood piles. It makes its web in structures ranging from outer toilets to garages, chicken houses, barns, cellars and the home itself.

Generally the female, responsible for the bite, is not aggressive unless bothered or very hungry. When guarding the egg sac the female is likely to bite.

The matured female is glossy black to sepia in color and covered with short hairs. The characteristic crimson hourglass marking on the underside of the abdomen varies from the distinct hourglass design to one comprising two or more distinct triangles, or an irregular longitudinal marking. The abdomen is globose and resembles a shoe button. See illustration page 91.

When the web is completed and established, the female spends the remainder of her days feeding on the victims caught in her web and guarding her egg sacs. The spider approaches the prey backwards, and engulfs her victim in a freshly spun strand, using either one or both hind legs to tie down the thrashing appendages. If she finds her prey hard to control, she ejects from her spinnerets large viscous droplets, which dry rapidly, making escape impossible. About this time she administers a lethal bite. *After being bitten, the victim struggles violently, and within a few minutes dies.* The body fluid of the victim is then sucked by the spider in her leisure time. Upon completion of the meal all points of attachment between the web and the victim are cut loose allowing it to drop from the web.



The spider is not usually aggressive toward human beings unless hungry, agitated, or disturbed while guarding the egg sac.

*Symptoms.* The bite is not always felt (it resembles a pin prick); however, a slight swelling (local) and two tiny red spots may appear. Pain, usually in the region of the bite, is felt almost at once and increases in intensity, reaching its maximum in 1 to 3 hours and continuing for approximately 12 to 48 hours. Stomach muscles become rigid and boardlike; there is a slight rise in body temperature, increased blood pressure, profuse perspiration, nausea and vomiting, chills and pallor.

*Treatment.* Send for a physician. Apply tincture of iodine at the site of bite to prevent secondary infection; keep the patient warm and quiet. Professional treatment for the bite of the black widow spider is mainly the use of opiates, hydrotherapy, and other measures to alleviate the pain.

# 7

## RADIATION HAZARDS AND CHEMICAL WARFARE AGENTS

### RADIATION AND RADIATION HAZARDS

Generally, the injuries resulting from an accident are immediate, and usually when a poison is taken into the body its effects are rapid; but when the body is exposed to excess radiation it may be several years before radiation damage makes itself known, unless the dosage received is extremely high.

Radiation emitted from radioactive materials such as radium or materials produced during the explosion of an atomic or thermonuclear bomb or in an atomic energy reactor can cause irreparable damage to the body even though the energy source is located some distance away. Many of the radiations are capable of penetrating considerable thicknesses of solid materials. It is true that their intensity is reduced in passing through these solid materials, but it is important to know the extent of reduction if safety is to be accomplished.

Distance, time, and shielding are the only factors over which we can exercise control if we are to protect ourselves against radioactive materials. The greater the distance from the source of radiation, and the shorter the time exposed to the radiation, and the greater the thickness of the shielding between the source of radiation and the body, the less possible harm. Thus protective measures are based on a combination of these three factors.

Intensity of radiation drops rapidly as distance is placed between the source of radiation and the body. The time factor can be easily calculated when the dosage rate is determined. Effective shielding can

reduce harm even from the most intense radiation from a nuclear explosion, the most effective shielding material being lead.

When an atomic or thermonuclear bomb explodes there is, in addition to blast, heat, and light, an emission of nuclear radiations consisting of alpha, beta, and neutron particles, and gamma rays. Some of these radiations are emitted simultaneously with the explosion; the remainder are liberated as certain elements made radioactive in the explosion go on emitting radiation in quantities that may be dangerous for periods of time varying from seconds to years.

Alpha particles emitted in an atomic explosion have fairly high energies but very short ranges. In air their range is a few centimeters at most. Unable to penetrate skin, they constitute no external hazard; but if allowed to enter the body through inhalation or otherwise they will produce a harmful effect internally.

Beta particles are electrons having a range in air of only a few meters; therefore they do not constitute as serious a hazard as other radiations. High-energy beta rays, emitted with almost the speed of light, may cause ionization of skin tissue which will produce in turn a persistent skin irritation resembling a burn.

Gamma and x-rays are liberated in tremendous quantities at the moment of detonation. This type of radiation is very penetrating and almost impossible to shield against. Walls of average buildings afford practically no protection against it. X-rays are similar to gamma rays except they have less energy and consequently less penetrating power. They produce similar effects on the body, and exposure to either can be fatal if the dosage received is large enough.

Neutron flux is the name given the vast quantity of neutrons released at the moment of the explosion. Neutrons are uncharged and have a range in the air of approximately 800 yards. Neutrons, like the beta particles, are liberated from the explosion with very high energies and can penetrate great thicknesses of materials. At Bikini the neutrons penetrated the hulls of ships located in the lagoon. When the neutrons are absorbed by the nuclei of the body elements, they produce isotopes which have different chemical characteristics from the elements out of which they are formed. These new isotopes react in abnormal chemical reactions, which in turn disrupt the normal body chemistry.

### EXTLRNAL AND INTERNAL HAZARDS

Where external radiations are concerned, it will be necessary to move either the source or the person, or to place sufficient and adequate shielding between the source and the person.

Internal hazards arise in the body either by ingestion, inhaling, or absorption of radioactive matter through a break in the skin. When this occurs the source of radiation will be located within the body. There these sources continue to emit high-energy alpha and beta particles, which ionize directly, killing blood cells, injuring blood-producing organs, and causing local irritations which often become cancerous. Radioactive material deposited in the body remains a long time and during its presence continues to be a source of radiation within the individual. There is no known way to neutralize or destroy these radiation sources, the only procedure being the normal rate of decay associated with radioactive elements and the excretion of the material from the body.

Following the explosion care must be exercised to avoid taking radioactive materials into the body by way of the mouth, nose, or openings in the skin. The average gas mask will give considerable protection. It is recommended that individuals do not smoke, eat, or drink while in a contaminated area.

### RADIATION SICKNESS

*Symptoms.* The major cause of radiation sickness is the ionization of body tissue. The effects on the body fall into the following categories:

1. There may be nausea and vomiting soon after exposure, and lesions of the mucous membranes of the mouth may appear. Within a few days bloody diarrhea may develop.

2. If the dosage or exposure was sufficient, there will be a loss of hair from the body within 2 or 3 weeks (usually not permanent). The skin becomes red and the fingernails become dry and brittle.

3. Gamma radiation reaches the bone marrow and retards the normal production of white blood cells, causing leukopenia (white cell deficiency). This increases the chance of infection and leads to anemia or loss of red blood cells. The result is a loss of skin color and general body weakness. Gamma radiation may destroy the blood platelets

whose function it is to assist in coagulation. This damage could result in hemorrhages.

4. Radiation produces temporary sterility.

*Treatment.* Good nursing and medical care, use of sterile procedures to prevent infections, transfusions of whole blood, administration of antibiotics (penicillin, streptomycin, etc.).

### DETECTION OF RADIATION

**Instruments of Detection.** Several instruments are used to detect radioactive radiations. We will discuss here the film badge, the pocket dosimeter, and the Geiger-Muller counter.

*The Film Badge.* Photographic films are often used in measuring gamma-radiation dosage and have become valuable in their use as personnel badges. The film badge is a small package containing several dental-size emulsions packaged in light-tight, thin, waterproof material across which is placed a thin metal sheet cut in the shape of a cross. The package is opaque to light but is easily penetrated by gamma rays. The beta particles do not penetrate the metal; therefore the blackening of the film is caused only by gamma radiations. Following the development and drying of the film, the density of the film is read on a densitometer.

A film badge worn by an individual engaged in radiological work is excellent and convenient for recording the total radiation to which an individual has been exposed during the period he has carried the badge. Care must be exercised in handling the films before development, because they are sensitive to light, heat, and moisture. At present certain emulsions when used with correcting filters can give roentgen dosages of gamma rays independent of energy from approximately 0.05 to 2 million electron volts (Mev).

*The Pocket Dosimeter.* The two types of pocket dosimeters both resemble a pocket fountain pen. One type widely used for monitoring is placed in an electrometer to measure the potential. The self-reading type has a calibrated scale included to make it possible to read the dosage at any time. A minometer is the charging-measuring instrument that is used in conjunction with the latter-mentioned dosimeter. This instrument is used to charge the dosimeter as well as to read it to determine the amount of radiation which it has passed through from the time it was last charged to the time the charge was again

measured. One minometer can be used in conjunction with several dosimeters.

Both the above types of dosimeters are ionization chambers and consist of a central wire electrode insulated from the case. The inside of the case is coated with graphite which acts as the other electrode. These electrodes are charged up to a known potential. If the pen has not been exposed to ionizing radiation and there is no leakage, the potential will remain the same. If the pen has been exposed to radiation, the air chamber will become ionized. The ions of opposite charges travel to the two electrodes and reduce the potential between them.

*The Geiger-Müller Counter.* The Geiger-Müller counter is especially useful as a portable, sensitive, light-in-weight detecting instrument for survey work and is probably the most convenient instrument for detecting gamma rays.

Because of their great penetrating power, gamma rays are probably the easiest radiations to detect. They are the most important radiations to measure accurately, because external exposure to large doses of these rays may produce dangerous physiological effects. The unit used in the measurement of gamma rays is the roentgen. The dosage rate is usually specified in terms of roentgens absorbed per unit time, e.g., r per minute or r per hour. Since radioactive emanations are invisible, it is possible to be exposed to a lethal dose of radiations and not be aware of the danger.

The Geiger-Muller counter has high sensitivity, but is useful only in detecting beta or gamma radiation. The G-M tube will not detect alpha particles, because these particles do not have sufficient energy to penetrate the tube wall. When the instrument indicates the presence of radioactivity by meter deflections, it can be assumed that gamma radiation is present.

## CHEMICAL WARFARE AGENTS

There is always the possibility that poison gas will be used in a war. In this chapter, the chemical warfare agents that have been used or were prepared in previous wars will be discussed. Should new substances be used it is possible their effects will be similar to those already known so that present treatments will still be helpful. There is also a possibility that several chemical substances will be used in combined form to make detection more difficult.

Many gas casualties could have been prevented if the victims had learned the factors determining the behavior of the various types of chemical warfare agents. It is not necessary to have a knowledge of chemistry in order to understand a few basic rules that govern the behavior of these warfare agents. Self-aid is most important.

The words "chemical warfare agents" are often associated with the term "poison gas," but most of the substances used are actually liquids or solids. Some of the methods that can be employed to transport these warfare agents to their destinations are bombs and shells, which, when exploded throw the liquids or solids into the air in drops or minute particles. Liquids in some instances are transported in tanks attached to airplanes and when released fall to the ground as a spray or fine mist. Some solids can be vaporized by heat in specially built dispersers and released as smokes. A few substances which readily enter a gaseous state can be released from cylinders by merely opening valves and allowing the agent to be carried to its destination by prevailing winds.

Regardless of whether we call these warfare agents poison gases, chemical warfare agents, or war gases, the terms all refer to substances used in war which by direct chemical action produce either toxic results on the human body, a screening smoke, or an incendiary action.

A toxic agent is one capable of seriously endangering health or destroying life. When we speak of a lethal concentration we refer to one that will kill an average person. The term harassing agent is used when we speak of an agent that incapacitates or delays the individual from continuing with his regular duties in a normal manner. Tear gases and irritant smokes are considered harassing agents. Chemical warfare agents are usually heavier than air and lie close to the ground when released. This is important to remember when selecting locations for shelter. A persistent agent is one that remains dangerous after ten minutes and against which further protection of some kind is necessary to keep from becoming a casualty. When no protection is needed after ten minutes, it is considered a nonpersistent agent. Persistence depends upon several factors such as the wind, weather, nature of the ground, and the terrain. In open areas, many warfare agents quickly dissipate and for this reason they are called nonpersistent. The liquid agents may persist and remain dangerous for several weeks.

Although an accurate identification of the chemicals is desirable, effective therapy does not necessarily depend upon an accurate diagnosis. Where signs of lung damage are present the treatment for

phosgene should be administered. Where a vesicant is suspected the treatment for mustard gas should be given, because the treatment is also of value against other vesicants. When the eyes and mucous membranes are irritated, whether the cause is a vesicant, a lung irritant, or a lacrimator, the same treatment is administered. It is the immediate and prompt treatment that is so important in all cases where a chemical warfare agent is used.

### VESICANTS

Mustard Gas is a heavy, oily, almost colorless liquid in the pure state. The commercial product is darker in color and has a pungent odor resembling that of horseradish, onions, or garlic.

Ordinary clothing will not furnish protection against this agent for long, since it will penetrate clothing, leather, and rubber goods very rapidly. Chloride of lime, which is used to decontaminate this agent, reacts violently when the dry lime comes in contact with the liquid mustard. The reaction is so violent that a red flame results from the heat generated by the chemical reaction. The product remaining after the reaction is harmless.

*Symptoms.* The eyes smart and are the first to show the effects of the mustard gas. This is followed by pain, edema, and the appearance of acute conjunctivitis. Sneezing, coughing, and a discharge from the nose may occur. The skin itches and blisters form which contain a clear fluid. Infection of the burns may occur. If the saliva or the secretion from the nose contain mustard gas and is swallowed, it may produce vomiting and epigastric pains. There is a pronounced irritation of the respiratory tract that often results in the mucous membranes of the bronchi and trachea becoming ulcerated. Respiratory infection is frequent and a number of deaths are caused by bronchopneumonia.

*Emergency Treatment.* Immediately remove all clothing and dispose of them in a closed receptacle. Remove excess mustard gently from the skin with dry clean pads. Dab the body with kerosine for several minutes. If the eyes are affected they should be irrigated for several hours with a 2% solution of sodium bicarbonate. The mouth and nose may also be washed out with this solution. A thorough washing under a hot shower with a strong soap as soon as possible is important. If there are gastrointestinal pains a warm diluted solution of bicarbonate of soda may be swallowed.



**Nitrogen Mustards** are a group of organic chemical derivatives of ammonia which vary in physical properties from liquids to low-melting solids. They are colorless to pale yellow and have faint odors varying from fishy or soft-soap-like to practically odorless. Their volatility varies from much less than mustard gas to five times greater. They are relatively readily hydrolyzed. The nitrogen mustards have recently been used as drugs for combatting leukemia types of cancer.

*Symptoms.* Similar to those described for mustard gas but action on the eyes is faster.

*Emergency Treatment.* Similar to that for mustard gas.

**Lewisite** is a heavy, oily and colorless liquid when pure, but the commercial product is dark in color with a geranium-like odor.

Leather and rubber goods give slightly more protection against lewisite than against mustard gas. Chloride of lime is also used to decontaminate against lewisite.

*Symptoms.* Similar to those produced by mustard gas.

*Emergency Treatment.* Similar to the emergency treatment given for mustard gas.

**Other Dichlorarsines.** Ethyl-, methyl-, and phenyldichlorarsine are heavy liquids having fruity odors.

*Symptoms.* Similar to those produced by mustard gas.

*Emergency Treatment.* Similar to the emergency treatment given for mustard gas. In addition allow the victim to inhale low concentrations of chlorine, such as are found in bleaching powder, Clorox, or Zonite, to relieve nasal irritation.

### LUNG IRRITANTS

Many of the warfare agents are lung irritants when in a gaseous state. A gas mask will give adequate protection against all the known lung irritants. The lung irritant agents are nonpersistent but even a short exposure may produce serious effects.

**Phosgene** is a colorless gas with an odor described as that of musty hay.

*Symptoms.* The eyes smart and tears flow. There is coughing, a catching of the breath, and a tightness in the chest. Respirations are shallow and deep breathing causes coughing which is painful. Early symptoms are headache, nausea, and vomiting. Cyanosis appears and there may be circulatory collapse. If cyanosis and collapse occur, the

pulse becomes rapid and weak. If severe, the patient may cough up blood which is frothy.

*Emergency Treatment.* Keep the victim lying down, quiet, and warm. Cardiac failure and collapse may occur with the slightest exertion. Move only on a stretcher. The victim should be put to bed and not allowed to get up for any reason. Administer hot drinks, but do not give alcoholic beverages. To relieve irritation of the respiratory tract a spray of 10% sodium thiosulfate may be given.

Oxygen is probably the most effective therapeutic aid that can be given, especially in cyanosis cases. A flow of from 8 to 10 liters a minute will aid in relieving cyanosis. In mild cases, administer oxygen for about four minutes in every fifteen. This will relieve headache, restlessness, and apprehension. Do not use artificial respiration, for it may damage the lungs. Bronchopneumonia usually develops and is treated in the usual manner.

Diphosgene is an oily liquid that smells like phosgene. It is also nonpersistent and its vapors are more lacrimatory than phosgene.

*Symptoms.* Similar to those produced by phosgene.

*Emergency Treatment.* Similar to the emergency treatment given for phosgene.

Chlorine is a greenish-yellow gas with an odor resembling that of bleaching powder. Here again the gas mask is important to protect the would-be rescuer against being a casualty. See Chapter 3.

*Symptoms.* Similar to those produced by phosgene.

*Emergency Treatment.* Similar to the emergency treatment given for phosgene.

Chlorpicrin is an oily, colorless liquid with a sweet odor resembling licorice or slypaper. A gas mask will afford protection to its wearer. See Chapter 3.

*Symptoms.* Similar to those produced by phosgene.

*Emergency Treatment.* Similar to the emergency treatment given for phosgene.

Nitrous Fumes are reddish brown and yellow gases and have a pungent odor. An all-purpose gas mask is necessary for protection.

*Symptoms.* Similar to those produced by phosgene.

*Emergency Treatment.* Similar to the emergency treatment given for phosgene.

## LACRIMATORS

Chloracetophenone is a crystalline solid having an odor resembling locust blossoms. Ethyliodoacetate is a brown, oily liquid with a pear-like odor, and Brombenzyl cyanide is a yellow, oily liquid with a bitter-sweet smell. The gas mask will give protection against all these agents. It is doubtful whether they will be used to any degree in warfare, but they are used today by police and military units to break up unlawful gatherings.

*Symptoms.* The sensory nerves of the cornea and conjunctiva are irritated and cause tears to flow. If the concentrations are high they may irritate the respiratory tract and cause a burning sensation. Exposed skin may become irritated.

*Emergency Treatment.* Usually facing the wind will be sufficient. The eyes may be washed with a normal saline solution, a 2% solution of sodium bicarbonate, or a boric acid solution. Do not rub the eyes.

## NOSE IRRITANTS

Adamsite is a yellow-green, granular solid but is seen as a yellow smoke and is considered an irritant smoke and sneeze gas. Diphenylchlorarsine is a white crystalline solid and is released as a vapor or fine smoke. A gas mask will give protection against both of these agents.

*Symptoms.* Irritation and pain in the nose, sinuses, and chest; headache, nausea and vomiting, with an increase of saliva and nose secretions. The victim will be greatly depressed, to the extent of attempting to take his own life.

*Emergency Treatment.* Remove the victim to fresh air. Allow him to inhale dilute vapors of chlorine as found in bleaching powder. Inhalations of ether and chloroform will give some relief. The eyes may be washed out with a 2% solution of bicarbonate of soda.

## NERVE GASES

Nerve gases were developed by the Germans during World War II but fortunately were not used before hostilities came to an end. The chemical formulas of these gases were kept secret but are now known. They are related to the phosphate esters (see Chapter 3). Their effects on the human body, preventive methods, control, and treatment are well understood. If gases are to be used in any future wars, these gases are the most likely to be employed. Like many other warfare

agents, they can be launched from sea-going craft, airplanes, rockets, mortars, bombs, or artillery. They are the most toxic and effective agents that could be used in long-range chemical attacks.

Some of the nerve gases are odorless; others have a sweetish, fruity odor. Some are persistent, others nonpersistent. The nerve gases, whether in vapor or liquid form, are rapidly absorbed by the body either by inhalation or absorption.

In the unprotected body the nerve gases cause the cholinesterase enzymes of the body to become inactive and in so doing allow an overproduction of the acetylcholine, which reacts unfavorably on the nerves and smooth muscles of our bodies.

Nerve gases can contaminate water and food supplies.

*Symptoms.* A feeling of tightness in the chest with difficulty in breathing, severe constriction of the pupils of the eyes; vision becomes dim, and the eyes pain. In severe cases there is cyanosis of the body surface due to an insufficient supply of oxygen in the blood. The victim develops tremors, convulsions, and paralysis, and finally dies.

*Emergency Treatment.* A gas mask and special clothing will afford protection for a short time. These gases penetrate ordinary clothing in a short time, and therefore special clothing must be worn even though it protects only slightly longer. In early stages of contamination, injections of atropine may be given to neutralize the effects of the gas on the eyes and lungs. The body must be quickly and thoroughly washed with soap and hot water. The new method of artificial respiration (back pressure arm lift) may be necessary in extreme cases. See Chapter 8.

#### SELF-AID

**Difference Between Self-Aid and First-Aid.** First-aid is defined as the immediate care pending the arrival of a physician. In the case of gas casualties or in the case of exposure to gas, no waiting period can be allowed. Self-aid is defined as the immediate care administered to oneself after exposure to gas attack. The word *immediate* must be emphasized.

**Urgency of Immediate Action.** On a preceding page we noted the rapidity with which a war gas works. In order to counteract it, self-aid action must be even more rapid. Gases may be developed which will have an even greater rapidity of action, particularly on the eyes. Every

effort must be made to protect one's eyes and to administer self-aid promptly. The nitrogen mustards also work speedily and require immediate attention.

**Methods Applicable to Civilians.** The Army has developed excellent methods, devices, and medicaments for self-aid. These are not available to all civilians. Therefore, civilians must be taught to take care of themselves in other ways.

(1) War gases, or other chemical agents used in warfare, stay close to the ground because they are heavier than air. To get out of a gassed area, simply walk against the wind, or go upstairs. Close windows and doors to prevent the entrance of gases. Stop up fireplaces or any other large opening, and turn off air-conditioning systems, if they are in operation.

(2) Certain gases are irritating and cause unpleasant burning sensations in the eyes, nose, lungs, or on the skin. They are usually quite harmless if there is short exposure to the gas. To avoid exposure, go to an upper floor and keep the windows closed. If gas or liquid chemical agents get on the skin, one harmful effect can be prevented if they are quickly removed by sponging with a cloth, such as a handkerchief, followed by prompt cleansing with common soap and water, preferably a shower bath.

(3) Some gases are spread as oily droplets or sprays which blister the skin and burn the eyes. Therefore, in the event of gas attack, do not look up. If the gas should get into the eyes and produce smarting and stinging, wash them out promptly with plain water. Do not press or rub the eyes.

(4) If clothing is contaminated with the liquid chemical agent or you have been in a gassed area, remove all clothing and cleanse yourself thoroughly with laundry soap and water. Do not touch clothing that has been contaminated; place it in a metal container so that it can be handled safely.

(5) Some war gases produce a heavy feeling in the chest or difficulty in breathing. The best protection against these gases is to get out of the gassed area quickly, lie down, and stay perfectly still until a doctor can be obtained.

(6) It must be remembered, an enemy's main purpose in using war gases is to produce panic. Do not aid the enemy by running or shouting.

The following additional information may be found useful. Immediately after exposure to the spray, liquid, or vapor of a chemical agent released from a plane or by bomb or other form of contact

(1) Strip off all outer clothing down to underwear outside a house. Leave the clothing and shoes outside, being careful not to step where shoes or clothes were.

(2) By means of a blotting action, using absorbent cotton or similar material or any cloth, remove the liquid from exposed parts of the body.

(3) Pour commercial sodium hypochlorite solution (Clorox, Zonite, etc.) over the exposed area. Wash with water.

(4) Place about one quart of a 2% solution of sodium bicarbonate (baking soda) in an enema bag or similar container and allow the solution to run into the open eyes, alternating from one to the other. If sodium bicarbonate is not available, do not waste time. Wash in a similar way with water. If an enema bag is not available, use any other means or method.

(5) Take a shower bath, using plenty of water, preferably hot water, and laundry soap. If a shower is not available, pour buckets of water over your body.

(6) If exposed to lung irritants or vapor of any gas, be sure to lie down and rest after the previous steps have been taken. Also keep yourself warm.

Because of the severe action of the nitrogen mustards on the eyes, it is imperative that they be washed out with water immediately. The skin should be washed thoroughly with soap and water.

If exposed to nerve gases use atropine syrets.

#### THE GAS MASK

When the atmosphere is contaminated and if there is sufficient oxygen present, a gas mask of some type must be worn for protection. Here we will discuss the canister type mask, the most common mask found in emergency work today. The purpose of a gas mask is to remove harmful chemical agents from the air we breathe, thereby protecting the face, eyes, and respiratory organs from serious injury from toxic and irritating gases, vapors, fumes, and smokes. Many of these chemical agents are deadly even when one is exposed to them for only a few seconds.

The finest gas mask in the world is useless if it is not worn properly;

therefore the greatest problem in protection is organization, training, and discipline. The gas mask today differs little in appearance from the mask used during World War I, but in reality it is a much improved piece of equipment. The mask today, besides being more dependable, is more comfortable to the wearer, will give longer service, and allows a wider area of vision. The canister used today gives better protection against the smokes and the more toxic chemicals used in warfare. The chemicals used in the canisters have been improved, and the activity of the charcoal has been increased several times. All of these improvements add up to a better and lighter canister. Regardless of whether the mask is a training mask, a service mask, a diaphragm mask, or a civilian mask, the operation is similar.

The canisters used to protect against warfare agents do not protect against certain gases found in industry. Ammonia and carbon monoxide, for example, which are commonly encountered in industry, are gases which the military and civilian defense masks will not protect against.

It must be remembered that the gas mask does not supply oxygen or manufacture it, and for this reason it must not be worn unless there is a sufficient amount of oxygen present.

**Construction.** The complete canister gas mask consists of three principal parts: the facepiece assembly, the canister, and the carrier.

1. The facepiece assembly consists of a rubber or rubberized fabric facepiece containing lenses, an exhalation valve, a hose connection, and a connecting hose. The facepiece assembly is kept in place by an elastic, adjustable band

2. The canister supplied with a mask depends upon the chemicals against which the mask is designed to protect the wearer. Canisters giving protection against one type of gas may be inefficient against another type. There are canisters available for nearly all the known toxic gases, vapors, fumes, or smokes. An all-service type canister can be obtained that will give protection against nearly all toxic gases, including carbon monoxide. The canister consists of a hose connection, one or two inlet valves, depending upon the type canister used, and chemicals for purifying the air to be breathed.

3. The carrier can be a metal case, a composition case, or a canvas case containing straps and buckles for attachment to the body of the wearer.

**Operation.** The mask is constructed to filter the air before it enters the facepiece. On inhalation the contaminated air first passes through the canister containing a filtration system. The filtration system comprises a mechanical filter and a chemical filter. The mechanical filter frees the incoming air from the solid and liquid particles and the chemical filter absorbs and neutralizes the toxic and irritating gases and vapors. After the air has been purified, it enters the facepiece so that it can be drawn into the wearer's lungs. Upon exhalation the air is expelled from the mask through the outlet valve.

The protection given by a canister mask is due primarily to the canister; the other components of the mask only prevent the air from entering the facepiece by any other route. No canister gives protection indefinitely, for the life of the canister is dependent upon the quantity of gas it is capable of removing from the air. There must also be sufficient oxygen present to sustain life. If a condition arises where there is not enough oxygen present, a self-contained oxygen breathing apparatus or a supplied-air respirator must be used. In the former, the oxygen is carried on the wearer's back or a device in which the oxygen is generated is worn. This type of apparatus is used commonly in mine rescue work where carbon monoxide and methane gases prevail, or where oxygen-deficient atmospheres are encountered. It must be remembered that no mask protects an individual against gases that can be absorbed through the skin. In their presence, protective clothing must also be worn.

**Fitting the Mask.** The adjusting and fitting of the mask should be done when it is first received so that it will be ready for instant use and will give full protection if it is ever necessary to put it on in a hurry. A gas mask is individual equipment and should be used by no one but the owner or the person to whom it is assigned. This prevents spreading colds, sickness, and contamination. The time may arise when promptness and a perfectly fitted mask will prevent the wearer from being another casualty.

**Putting on the Mask.** Place the thumbs on the inner side of the mask just below the head harness with the fingers supporting on the outer side of the facepiece. Thrust the chin forward and place the chin into the chin indentation of the mask. Bring the head harness over the head with the fingers, and straighten the straps of the head harness at the same time. Smooth out the facepiece, beginning at the



chin, to eliminate creases and channels. Finally, check the mask to insure its proper fit.

**Checking the Mask.** Place the palm of the hand over the intake valve on the bottom side of the canister and inhale. If the mask is properly fitted it will collapse against the face.

**Safety Line.** A good precaution wherever possible is to attach a safety line to the person making a rescue, so that should the rescuer need assistance he can be reached quickly by following the safety line.

### PROTECTIVE CLOTHING

To protect individuals against chemical warfare agents, a lot more knowledge is necessary than just knowing how to wear a gas mask. Because some of the chemicals used will blister the skin it is necessary and vitally important that some means be employed to afford protection. Agents that will affect all parts of the body are more likely to be used than those which will affect only the eyes, skin, or the respiratory organs. It is for this reason the vesicants such as mustard gas, lewisite, and the dichlorarsines are so prominent among warfare agents. When inhaled, the gases affect the lungs. A small amount in the air will cause irritation of the eyes. If the clothes become contaminated, the chemicals will soon penetrate to the skin and cause burns.

*During World War I it was soon discovered that men could not work or fight for any length of time with the impervious garments they were provided with to protect themselves against the warfare agents. This early issue clothing being impervious to liquid and gas, prevented the escape of heat and water vapor from around the body, which made wearing it difficult for periods longer than thirty minutes.*

After World War I, more practical protective clothing was developed that was permeable to air but was treated to carry a war-agent-reacting substance within the fabric. Such clothing will protect against vapor or light concentrations of the blister gases. To provide a more complete protection, underclothing should also be treated. Heavy special shoes, rubber boots, hood and goggles should also be worn. This latest type of clothing is not too difficult or uncomfortable to wear and may be successfully cleaned by using proper laundering methods.

To lessen your chances of becoming a casualty the following regulations should be carefully followed:

1. Even though properly attired in protective clothing and gas mask, no one should enter a gassed area alone. First-aid and rescue personnel should work together in team fashion and be ready to help each other should it be necessary.

2. Before reporting for duty or entering a gassed area all protective clothing and equipment should be carefully examined and tested.

3. Carefully check to see that you have the proper canister for the agent in which you are to work. Special canisters are necessary for carbon monoxide, hydrogen cyanide, and the cyanide derivatives.

4. If there is any question of there being insufficient oxygen in the gassed room or area use self-contained oxygen breathing equipment or supplied-air respirators.

5. In the event persistent vesicant agents were used, make sure your stay in the contaminated area is short, even though you are wearing protective equipment.

6. Upon return from a contaminated area, immediately remove all clothing as quickly as possible and take a thorough bath under hot water. Make sure the clothing you take off is properly disposed of in closed metal containers so they can be destroyed or decontaminated later.

### DECONTAMINATION

Decontamination is one of the most difficult problems of collective protection. The removal of persistent vesicants such as mustard gas and lewisite from materials, buildings, and earth will involve considerable supplies and labor. Everything these vesicants touch will remain dangerous for several days. The most logical solution would be to vacate the area and buildings as soon as possible. Should there be some reason this cannot be done, it will be necessary to begin decontamination procedures immediately, although this is practical only on a small scale. All that should be decontaminated in the field are certain small areas in highly important places. Where cities are involved almost all sections must be thoroughly gone over, the work being done as efficiently as possible.

Where decontamination work is necessary, provisions should be made to obtain well-trained personnel equipped with proper protective clothing. Showers should be provided for thorough cleansing and dressing rooms to change from contaminated clothes to clean attire. Arrangements should be made for disposing of contaminated clothing.

Since chloride of lime is necessary to destroy mustard gas and lewisite, huge stockpiles of this chemical should be made available. The method for using chloride of lime consists of making a mixture of three parts earth and one part chloride of lime and spreading it over the contaminated ground, turning it under to a depth of approximately twelve inches. Another mixture is then spread over the top and finally a layer of fresh earth. Paved areas may be flushed with heavy streams of water and covered with a paste of chloride of lime which is left on for twenty-four hours. The area is again flushed with streams of water and then coated with a solution of sodium silicate. Wood should be covered with a paste of chloride of lime, washed off, and the treatment repeated. Metal is first wiped down with kerosine or gasoline, covered with chloride of lime paste, washed off, scrubbed with soap and hot water, and left out in the sun and air for as long as possible. Do not use chloride of lime paste on gears or machinery, because it will cause the metal to corrode. Clothing should be steamed if only slightly contaminated. Leather may be steamed or treated with chlorine dissolved in carbon tetrachloride. Food should be destroyed and water well boiled. If the water is contaminated with lewisite, or the chlorarsines it should be destroyed, because they contain arsenic.

# 8

## EMERGENCY TECHNIQUES

In addition to the chemical treatments for poisons, there are several types of emergency equipment and techniques that may be called into use in an emergency. Those taken up in this chapter are: artificial respiration, the inhalator, and treatment for shock.

### **ARTIFICIAL RESPIRATION—Back Pressure-Arm Lift Method**

Never assume that death is present because signs of life are absent. Certain accidents cause cessation of breathing; death results a short time after breathing stops.

Breathing can be carried on for the victim by alternately compressing the lungs and releasing the pressure, thereby causing a flow of air into and out of the lungs. This method of aid to the victim is known as *artificial respiration*.

Many such methods have been used in the past years, and many types of artificial respiration are used today; but the method that is universally used and accepted by most organizations in the emergency field is the back pressure-arm lift method.

### **STANDARD TECHNIQUE**

#### **Position of the Victim.**

1. Place the victim in a prone position (face down).
2. Raise and bend the victim's elbows to a point where the hands can be placed one upon the other with the palms of the hands facing downward.
3. Place the victim's face on the hands with the head turned to one side.
4. Immediately begin artificial respiration.



POSITION OF VICTIM, WITH INDICATIONS OF  
OPERATOR'S POSITION FOR ARTIFICIAL RES-  
PIRATION, ARM LIFT METHOD

**Supplementary Related Directions.** It is most important that artificial respiration be started without delay. Have someone present check the victim's mouth to make certain that there are no foreign objects obstructing the passages. Make sure the head is not flexed forward and do not allow the chin to sag, or obstruction of the respiratory passages will occur. Pull the tongue forward. These important details must be attended to when the subject is placed into position or as soon after as possible. If there is a slight incline of the ground, place the victim's body with the head and shoulders toward the low part of the incline so that fluids will drain more easily from the respiratory passage. A smooth rhythm is desirable when performing artificial respiration. Keep the victim warm, and when revived, keep him quiet and lying down until he is seen by a physician.

**Position of the Operator.** Facing the victim, kneel on either knee. Kneel on both knees if it is more comfortable, placing one knee on each side of the victim's head. If taking the position of kneeling on one knee, place that knee on the side of the victim's head, close to the forearm. Place the opposite foot near the victim's elbow. Place your hands with the tips of the thumbs just touching on the flat of the victim's back in such a manner that the heels of the hands lie just below an imaginary line running between the victim's armpits. Spread the fingers downward and outward.



STARTING POSITION

**Compression Phase.** From the position of sitting on your heel or heels rock forward until your arms are almost vertical. Keep your elbows straight throughout this movement and allow the weight of the upper portion of your body to exert a slow, steady, and even pressure downward upon the hands. This movement forces the air out of the lungs.



COMPRESSION PHASE

**Expansion Phase.** When you reach the position where your arms are almost vertical release the pressure by taking your hands off the victim's back and begin your rock or roll backward. On your return to the original starting position grasp the victim's arms at a point just above his elbows and draw his arms upward and toward you. Apply only enough pressure to where you feel a resistance and tension

of the victim's shoulders. Keep your arms straight and as you rock backward the victim's arms will be drawn toward you. When you reach the point where resistance is felt release his arms and let them drop. This completes the full operation. The purpose of the arm lift is to expand the chest, arch the back, and relieve the weight on the chest. The complete cycle takes about 5 seconds and should be repeated about 12 times a minute.



LIFTING THE ARMS IN THE EXPANSION PHASE



RELEASING THE ARMS AT THE END OF THE EXPANSION PHASE

### ARTIFICIAL RESPIRATION—MOUTH-TO-MOUTH METHOD

The following method of artificial respiration for use in reviving infants and small children has been adopted by the American Red Cross. Some authorities recommend this method for adults also.

Drawing 1 shows a mother using the middle finger of her right hand to clear the child's mouth of any foreign matter. Using the same finger, she holds the child's tongue forward.

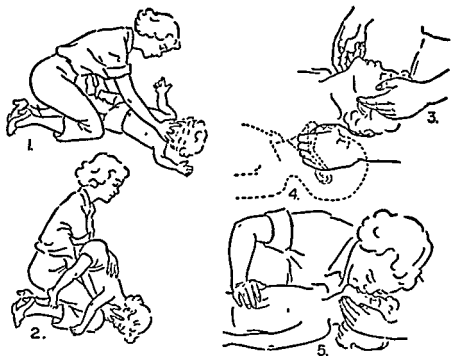
In Drawing 2, the mother has turned the child over her right arm in a face-down, head-down position. With her left hand she will pat the child firmly on his back to help in dislodging any foreign object in the air passage.

Drawing 3 shows the child placed on his back and the mother using the middle fingers of both hands to lift the lower jaw from beneath and behind so that the jaw "juts out."

Drawing 4 shows the jaw being held in the "jutting out" position.

Drawing 5 shows the mother covering the child's mouth and nose with her mouth. From this position she will breathe into the child

with a steady, even action. With the right hand she will apply continuous moderate pressure to the child's abdomen between the navel and the ribs to prevent the stomach from being filled with air.



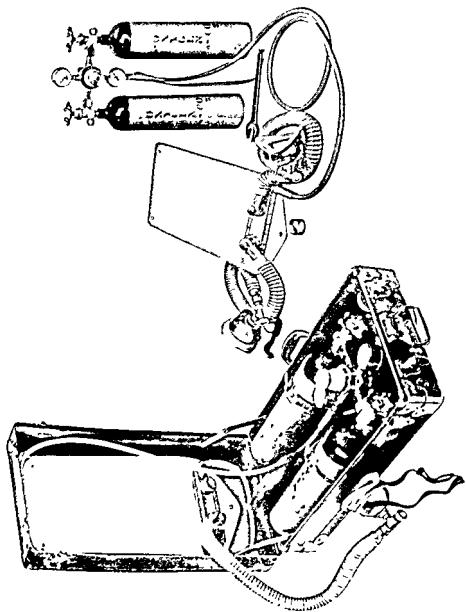
### THE INHALATOR

It has been proved through long experience that an administration of a mixture of 5% carbon dioxide for stimulation, and 95% oxygen for ventilation of the respiratory system, speeds recovery whenever the lungs have been hindered in their proper functioning. An inhalator provides this gaseous mixture when artificial respiration is being applied or when the victim is breathing by his own effort.

#### Inhalator Instructions

1. Open the valve at the top of the cylinder and make sure the pressure gage registers the amount of oxygen remaining in the tank.
2. Next, open the low-pressure regulating valve until the breathing bag becomes partly inflated. It is not desirable to fill the bag completely, for it will then be difficult to see the bag breathe. About 50%





DAVIS INHALATOR

inflation will give best results. The reducing valve is opened or closed according to the individual's lung capacity. *Do not allow the bag to collapse.*

3. Make sure that the facepiece fits the victim's face firmly, covering the nose and mouth. This insures a constant concentration of oxygen at the points of inhalation. When the reducing valve is completely open and the victim takes enough aid to collapse the bag, the air inlet valve or mica disc on the facepiece automatically opens, allowing fresh air to complete the inhalation.

4. After the patient has started to breathe, about twenty minutes use of the inhalator is usually all that is necessary.

5. When the pressure gage shows zero, it is time to replace the cylinder or change to another cylinder if the apparatus is of the two-tank type. This should be done without stopping the flow of carbogen. First close the valve at the head of the empty cylinder and the one between the cylinder and the reducing valve. Then open the valve at the head of the new cylinder and the valve between the new cylinder and the reducing valve and the inhalator will continue its normal operation.

NOTE. After using, sterilize the facepiece with a disinfectant solution. Do not use steam or boiling water.

### TREATMENT FOR SHOCK

Shock occurs more or less from all injuries. The stability of the nervous system is an important factor in determining the degree of shock present. What might be a mild case in one individual may be a severe case in another. This condition may vary from a slight feeling of faintness to a condition of collapse, in which the forces of the human body are so exhausted that death may result.

The injury sustained is the primary cause of shock; and in many cases shock can be overcome by rest and retaining body heat. However, there are cases of shock resulting from burns, abdominal injuries, severe crushing injuries and poisoning from strong acids and alkalies, where shock develops rapidly and endangers life. In these cases it is good emergency treatment to treat for shock while the injury is being taken care of.

*Symptoms.* When shock occurs there is a stagnation of blood in the region of the abdomen. As a result—

The pulse is rapid, weak, and irregular.

The face is pale, and a cold sweat is present, especially noticeable on the forehead.

The body is cold and often a severe chill develops, frequently accompanied by nausea and vomiting.

The patient is weak, listless, and dull and takes little interest in what occurs around him.

He may lapse into complete unconsciousness.

*Treatment.* The purpose of shock treatment is to bring the accumulated blood from the abdominal region back into circulation, to bring the proper blood supply back to the brain and to the surface of the body where it is vitally needed, and to administer proper stimulation. Important procedures to accomplish these results are—

Wrap completely in blankets. At least four thicknesses of blankets beneath the patient are important and necessary.

Place the patient on his back with the head low. This can be accomplished by raising the foot of the bed or object on which he is lying. If the person is on the ground, place something under the feet and legs.

If the victim is conscious, and only if he is conscious, give him a stimulant such as hot coffee or tea.

We must bear in mind that the treatment of shock is often just as important as the injury itself. Since shock can result in death, it is important that a physician be summoned as soon as possible.

## A SCHEME FOR THE IDENTIFICATION OF POISONS

In Chapter 2 the identification of poisons by chemical means was considered and Chapter 3, concerned with the special properties of poisons, detailed the more specific methods for identifying a given poison. Occasions arise in which it is important to identify a poison under circumstances that do not permit a full-scale toxicological examination. Under such conditions the scheme devised by Goldstone (1)\* may find use. This scheme can be carried out with equipment generally available in high school and most laboratories.

### GENERAL RULES OF PROCEDURE IN THE LABORATORY

As a general guide, the following suggestions made by Nobel (2) are valuable and will be helpful in the identification of poisons.

1. The analyst must be aware of extreme personal danger in dealing with unknown compounds. For example, an unmarked paper bag filled with grayish granules was found near a dead man. The granules were identified as calcium cyanide, a product used in commercial exterminating, which liberates hydrogen cyanide even in neutral aqueous solution. Autopsy confirmed cyanide as the cause of death.

2. The analyst must be alert to the possibility that a toxic compound found near the patient or even in the gastric contents may not be primarily responsible for the observed clinical picture. There are numerous cases, especially among suicides, where more than one poison is involved. Sometimes this occurs because the first poison is relatively slow acting, thus giving the victim enough time to hunt up another toxic substance.

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\* Numbered references are to be found in full at the end of this chapter.

3. By preparing a master chart of many of the capsules and pills manufactured by pharmaceutical houses, the analyst may simplify the identification of proprietary drugs. Each pill or capsule is placed in a test tube labeled with the trade name and chemical composition. Fortunately, the capsules are made in a wide range of color combinations, shapes, and sizes. It is thus possible to identify an unknown capsule in a matter of seconds if it can be matched with one in the collection. A confirmatory chemical test should always be run because of the possibility of duplication of shape and color by different drug houses.

4. The analyst may have to rely on many sources of information in obtaining a lead on the chemical composition of commercial and natural products. Several books have been found to be especially helpful (3, 4, 5). A careful reading of the label may also give valuable information. The nearest Poison Control Center (see page 24) may have the desired information in its files. As a final recourse one may contact the manufacturer directly.

### METHODS AVAILABLE

Nobel points out that although the total number of poisons is large, only about 19 compounds or their derivatives are involved in the majority of cases. These are antimony, arsenic, barbiturates, carbon monoxide, chlorinated hydrocarbons, cyanide, ethyl alcohol, fluoride, formaldehyde, iodine, lead, mercury, methyl alcohol, morphine, paraldehyde, phenols, phosphorus, salicylate, and strychnine. Prior preparation of methods, apparatus, and reagents to detect and to determine quantitatively these poisons in biologic fluids is to be considered as an initial step in adequately handling most cases of acute and chronic toxicity encountered by the laboratory.

Simple methods may sometimes be selected (6, 7, 8) which are not a burden to a laboratory with limited space and equipment. More than half the poisons mentioned can be detected with the aid of glass flanges, Conway dishes, and a copper coil. For example, the aeration of 1 microgram of cyanide (9) through an alkali-ferrous sulfate-treated disc of filter paper supported by two glass flanges will produce a blue color in 5 minutes. There are similar methods for the determination of carbon monoxide (10) using a palladious chloride-impregnated filter-paper disc, and for elemental phosphorus (11) using a silver nitrate-treated disc. These methods may be used quantitatively by

comparing the color produced with the colors of standards run under identical conditions.

Conway methods have been developed for the major toxic volatile compounds (12). Although they usually require more time than the aeration methods to produce an analytic result, their simplicity is a compensating factor. This liability has been overcome in a blood-alcohol method (13) by incubating the Conway dish at 90° F for 20 minutes.

The utility of the Reinsch test (14) has been increased by a scheme of analysis able to detect amounts of mercury, bismuth, arsenic, antimony, selenium, and tellurium that are invisible on the copper collector.

The frequency of encounter with salicylates and barbiturates is responsible for methods (15, 16) of their analysis being generally available in the clinical laboratory. The determination of other non-volatile poisons may require more complex methods (17, 18, 19). Newer techniques involving the use of filter-paper chromatography, ion exchange resins, and both ultraviolet and infrared absorption have been applied to the determination of nonvolatile poisons (20).

Sometimes a method is too recent to have gained access to published volumes. This is found to be especially true in attempts to analyze some of the newer pharmaceutical preparations. One may contact the pharmaceutical firm directly for aid or consult the current literature. It has occurred that a firm was unable to suggest an adequate method for the analysis of their product in a biologic system, yet a method was located in *Chemical Abstracts*.

### THE GOLDSTONE SYSTEMATIC METHOD FOR POISONS

While the Goldstone method (1) was originally designed for the detection of poisons in foods, it can be readily adapted to the analysis of vomitus, urine, and other materials.

It is most important to note the appearance and odor of the material being analyzed. As is stressed in other sections of this book, these attributes are often indicative of the poison. Thus vomitus colored blue is indicative of the presence of iodine if starch is present; it will be colored green if the poison was copper sulfate, Paris green, or Scheele's green; it is colored brown or has the color of coffee grounds if acid or alkaline corrosive substances are involved.

**Odor.** The presence of toxic substances such as yellow phosphorus, cyanides, phenols, and industrial solvents even in low concentrations is revealed by their characteristic odors.

**pH Value.** Macerate 0.5 gm. of the sample in 2 ml. of distilled water in a test tube. Allow the suspended matter to settle, decant a few drops of the supernatant liquid on to a white spot plate, and add one drop of universal indicator. Compare against standard buffer solutions to which one drop of indicator has been added.

**Phenol: Reagents: Gibbs' Reagent:** Dissolve 0.1 gm. of 2,6-dibromoquinonechloroimide in 25 ml. of 95% ethyl alcohol. Stored in a brown glass stoppered bottle in refrigerator, it remains stable for a week. Discard when the solution turns brown.

**Sodium Borate Buffer Solution:** Prepare a saturated solution of sodium baborate in water.

**Procedure.** To the residue remaining in the test tube in the pH value determination, add 5 ml. of sodium borate buffer solution; shake, test with litmus paper to check the alkalinity. If the solution is not alkaline, add a drop or two of sodium hydroxide solution, never ammonium hydroxide. Allow to settle and decant or filter into another test tube. A perfectly clear solution is not essential. Divide the solution between two test tubes, and to one serving as a control add one drop of dilute phenol solution prepared by dissolving 100 mg. of phenol in 100 ml. of water. Now add 3 drops of Gibbs' reagent to each tube and shake. The formation of the deep blue indophenol dye indicates the presence of phenol.

**Confirmatory Test.** Transfer 10-25 gm. of sample to a distilling flask, cover with 75 ml. of water, make slightly acid with sulfuric acid, and distill 50 ml. into a separatory funnel. Shake out the distillate with two 25-ml. portions of ethyl ether and evaporate the combined ether extracts slowly on a steam bath. Take up the residue in 5 ml. of sodium borate buffer solution, then add three drops of Gibbs' reagent. The presence of phenol is confirmed by the formation of the deep blue indophenol dye.

**Cyanides, Yellow Phosphorus, and Zinc Phosphide. Reagents: Ammonium Molybdate Solution:** Dissolve 10 gm. of molybdic acid,  $\text{MoO}_3$ , in a mixture of 15 ml. of ammonium hydroxide solution (sp. gr. 0.90) and 27 ml. of water. Cool and pour slowly with constant stirring into a cool mixture of 49 ml. of nitric acid (sp. gr. 1.42) and 115 ml. of





water. Keep in a warm place for several days or until a portion heated to 40° C deposits no yellow precipitate of ammonium molybdiphosphate. Decant solution from any sediment and preserve in a glass-stoppered bottle.

**Picric Acid Test Paper:** Wet a sheet of filter paper with a saturated water solution of picric acid and allow excess liquid to drain. Air-dry and cut into strips 1 × 7 cm.

**Procedure.** Macerate 50 gm. of sample in 50 ml. of water in a 250-ml. Erlenmeyer flask and add 10 ml. of tartaric acid solution. Suspend over the surface of the liquid a test paper strip moistened with a drop of silver nitrate solution, prepared by dissolving 10 gm. in water and diluting to 100 ml., and a picric acid test paper strip moistened with a drop of sodium carbonate solution. Warm the mixture for 15 minutes at 50° C on a steam bath. Presence of hydrocyanic acid is indicated by a red rose coloring of the picric acid paper. Blackening of the silver nitrate paper may indicate the presence of yellow phosphorus or zinc phosphide. Volatile substances such as formaldehyde, formic acid, and hydrogen sulfide also blacken silver nitrate; hence a positive paper strip test must be confirmed by the distillation test.

**Confirmatory Test.** Suspend 25 gm. of the sample in 200 ml. of water, make slightly acid with sulfuric acid, and distill in a dark room using an ordinary distilling apparatus with an upright condenser, or preferably that described by McNally (21). Presence of yellow phosphorus is confirmed by the appearance of a luminous ring in the upper part of the condenser. Minute amounts of hydrocyanic acid and yellow phosphorus will reveal their presence by characteristic odors if the condenser exit is cautiously smelled. If zinc phosphide is present phosphine is generated and this also has a very characteristic odor. Allow the vapors to condense into a flask containing a few milliliters of dilute nitric acid. Phosphorus and phosphine are oxidized to phosphoric acid, which is precipitated as the yellow molybdiphosphate on the addition of ammonium molybdate solution.

**Reinsch Test for Arsenic, Antimony, Bismuth, Mercury.** Add 20 ml. of concentrated hydrochloric acid to the Erlenmeyer flask containing the material used in the paper strip test for phosphorus and cyanide. Drop in it a strip of clean, burnished copper foil about 1 cm. square and allow to simmer on a hot plate for one-half hour. The presence of arsenic, antimony, or bismuth is indicated by deposition of a bluish-

black plating of the reduced metal on the copper foil. Mercury salts deposit a shiny silvery plating of the free metal.

*Confirmatory Tests.* Carefully wash the plated copper foil with water, dry with alcohol and ether, place in a small dry test tube and cautiously heat over a small flame. Arsenic, antimony, and mercury are deposited on the cooler area of the inner surface of the tube directly above the copper foil. Examine through a low powered microscope. Arsenic, as the trioxide, is deposited in characteristic octahedral crystalline form, mercury as a mass of minute opaque globules, and antimony as an uncharacteristic amorphous smudge. Bismuth does not volatilize, but its presence can later be confirmed in the ash of the sample.

*Ashing.* Transfer 50 gm. of the sample to a porcelain crucible, wet down with 1 ml. of saturated sodium carbonate solution, dry in an oven, carefully burn over a Bunsen flame, and complete to a gray or white ash at 500° C in a muffle furnace.

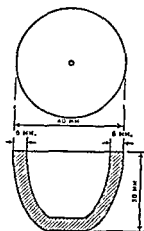
*Fluorides: Apparatus: Fluoride Etching Crucible:* A satisfactory crucible for performing the etching test for fluorides is not available commercially but may easily be fashioned in the laboratory.

Place a 30-ml., tall-form, porcelain crucible on a wire gauze over a Bunsen burner and melt sufficient printer's linotype metal to almost fill the crucible. After cooling remove the mold by gently tapping the overturned crucible. Clamp the mold in a turning lathe and bore out to shape and approximate dimensions shown in the figure. Place the top edge against a piece of sandpaper set on a flat surface and rub until smooth. For the cover, hammer a slug of lead on a flat metal surface to a thickness of 1 mm. and cut to size with a pair of shears. Smooth with sandpaper and punch a hole in the center.

Clean after each test by soaking in hot alkali solution and scrubbing with a wad of steel wool.

*Procedure.* Transfer a portion of the ash to a metal etching test crucible, moisten with a drop of water, and cautiously add concentrated sulfuric acid, drop by drop, until effervescence ceases. Wet the top edge of the crucible with sulfuric acid to form a seal, place cover on and set a glass microscope slide over hole in cover. Heat the crucible on a hot plate for 1 hour, wash and dry the slide and examine its surface for any etching produced by the generation of hydrofluoric acid. When the etching is very light due to small concentration of

fluorine, breathing on it will render it more distinct, or its roughness may be felt by gently scratching with the fingernail.



FLUORIDE ETCHING  
CRUCIBLE AND COVER

Hydrofluoric acid in the presence of a borate forms a volatile borofluoride which does not have an etching action on glass. Hence, when boron is present its interference must be eliminated by a separation of calcium borate from calcium fluoride based on the insolubility of the latter in dilute acetic acid (22).

In a similar manner, hydrofluoric acid reacts with silica to form the volatile fluosilicic acid, and this too lacks the ability to etch a glass surface. Here, however, it is unnecessary to make a separation, for the formation of fluosilicic acid serves as the basis of an even more sensitive test for a soluble fluoride than the etching test, for which it may be substituted or used as a confirmatory test, in the manner adapted by Gettler and Ellerbrook (23) for the detection of fluorine in tissues.

**Confirmatory Test.** Transfer a pinch of the dry ash to a 5-ml. porcelain crucible, mix with an equal amount of powdered glass or silica, cautiously add a few drops of concentrated sulfuric acid, and immediately cover with a microscope slide from the under surface of which is suspended a small drop of sodium chloride solution. Place the crucible on a hot plate maintained at a temperature of  $150^{\circ}\text{C}$  and

put a drop of cold water on the upper surface of the slide directly over the suspended drop, to retard evaporation. After 5 minutes heating remove the slide, allow the suspended drop to dry in the air, and examine under a microscope (450 magnifications) for six-pointed stars or hexagonal crystals of sodium fluosilicate. Ten micrograms of fluorine under this treatment should be detected without difficulty.

**Borates.** Dissolve the remainder of the ash in 20 ml. of water and make slightly acid to litmus paper with hydrochloric acid. Moisten a strip of turmeric test paper with a drop of the solution and allow to dry in air. Presence of a borate is indicated by a cherry red coloring of the test paper, which changes to a dark blue-green on wetting with a drop of ammonium hydroxide and is restored to the blue-green by acid.

**Soluble Barium Salts.** Add 5 ml. of concentrated hydrochloric acid to the solution of the ash obtained in the test for borates, and evaporate to dryness on a steam bath. Redissolve the residue in 25 ml. of hot water, filter, and wash into a 125-ml. Erlenmeyer flask. To 1 ml. of the filtrate in a test tube add a few drops of dilute sulfuric acid. A white precipitate of barium sulfate indicates the presence of a soluble barium salt.

**Lead, Bismuth, Copper, and Cadmium.** Pass a current of hydrogen sulfide gas through the filtrate obtained in the test for barium salts for 15 minutes and allow to stand until the precipitate coagulates. Pass through a paper filter, wash, and retain the filtrate for the detection of zinc and thallium. The precipitate, which may contain tin, lead, copper, bismuth, and cadmium is subjected to the procedure for separating and identifying metals of this group.\*

**Zinc.** Boil the filtrate obtained in the separation of the copper group to remove hydrogen sulfide and make alkaline with saturated aqueous sodium carbonate solution, precipitating zinc, iron, and the alkaline earth metals. Filter, wash with water, and retain the filtrate for the detection of thallium. Return precipitate and paper to the original flask, add 25 ml. of dilute hydrochloric acid, 5 ml. of bromine water to oxidize any iron present, boil to remove excess bromine, and add an excess of ammonium hydroxide to precipitate iron and alkaline earth phosphates. The zinc remains in solution. Cool, filter into

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\* Detailed in Chapter V of Jacobs, *The Chemical Analysis of Foods and Food Products*, 3d edition, Van Nostrand, Princeton, 1958.

a Nessler tube, add 10 ml. of hydrochloric acid (1:1), then 1 ml. of 3.5% potassium ferrocyanide solution and dilute to 100 ml. The presence of zinc is indicated by the formation of a white precipitate of zinc ferrocyanide. Since many foodstuffs, particularly the proteins, contain small amounts of zinc, it is advisable for the analyst to run a control along with the sample to accustom himself to estimate roughly small concentrations of zinc. Pipette 2 ml. of standard zinc chloride solution, add the reagents, and compare the turbidities in the two tubes. Prepare the standard zinc chloride solution by dissolving exactly 100 mg. of chemically pure zinc in hydrochloric acid and dilute to 1 liter. Each milliliter of this solution is equivalent to 0.1 mg. of zinc.

**Thallium. Reagent:** Sodium Polysulfide Solution. Dissolve 48 gm. of sodium sulfide,  $\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$ , and 4 gm. of sodium hydroxide in water, add 1.6 gm. of powdered sulfur, shake until sulfur dissolves, filter, and dilute to 100 ml.

**Procedure.** Add 1 ml. of sodium polysulfide solution to the alkaline filtrate obtained in the detection of zinc. A brown precipitate of thallium sulfide indicates the presence of thallium. Let stand until the precipitate coagulates, filter and wash, and dissolve the precipitate in a few cubic centimeters of dilute sulfuric acid; boil to remove hydrogen sulfide, cool, and neutralize exactly with ammonium hydroxide, using litmus paper as indicator.

**Confirmatory Test.** Divide the solution into two equal portions in test tubes. Make one portion slightly alkaline with ammonium hydroxide and add 1 ml. of 10% potassium iodide solution. A yellow crystalline precipitate of thallium iodide is formed. To the other test tube add 1 ml. of 5% potassium chromate solution, producing a yellow precipitate of thallium chromate.

**Alkaloids. Reagents:** Mercuric Chloride Solution: Dissolve 5 gm. of mercuric chloride in water and dilute to 100 ml.

Platinic Chloride Solution: Dissolve 5 gm. of platinic chloride,  $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ , in water and dilute to 100 ml.

Wagner's Reagent: Dissolve 1.27 gm. of iodine and 2 gm. of potassium iodide in water and dilute to 100 ml.

**Procedure.** Transfer 50 gm. of sample to a Florence flask, macerate in 50 ml. of 80% alcohol, add 5 ml. of tartaric acid solution and reflux on a steam bath for 1 hour. Connect the flask with a suitable con-

denser and distill over 5 ml. of liquid, retaining this for the detection of methanol and formaldehyde if the nature of the material is such that the presence of either or both of these substances is suspected. Filter the mash, wash well with 80% ethyl alcohol, and evaporate the filtrate on a steam bath to a volume of 5 ml. Slowly add 50 ml. of 95% ethyl alcohol, stirring and breaking up any clumps formed with a glass rod, again filter and wash with ethyl alcohol. Evaporate on a steam bath to remove the alcohol, dilute to a volume of 25 ml. with water and transfer to a separatory funnel. Extract with three 25-ml. portions of ethyl ether, wash the combined ether extracts twice with 2-ml. portions of water, and add the washings to the original water solution. This ether extract from acid solution may contain in addition to fat such compounds as salicylic acid, acetylsalicylic acid, barbituric acid, acetanilid, chloral hydrate, DDT, phenols, and organic solvents, which may be tested for if their presence is suspected.

Make the water solution distinctly alkaline to litmus paper with ammonium hydroxide solution and extract with three 25-ml. portions of ethyl ether, followed by two extractions with 25-ml. portions of chloroform. Retain the water solution for the detection of oxalates. After washing the combined solvent extracts with several 2-ml. por-

#### CHARACTERISTICS OF MICROCHEMICAL TESTS FOR ALKALOIDS (18)

<i>Alkaloid</i>	<i>Reagent</i>	<i>Description of Crystals</i>
Atropine	Wagner's	Rods and triangular plates, singly and in groups
Brucine	Mercuric chloride	Transparent, rectangular plates and rosettes of thin plates
Cocaine	Platinic chloride	Delicate feathery crystals
Codeine	Wagner's	Red-brown precipitate, crystallizing in yellow blades, extending in branches
Heroin	Platinic chloride	Spherical clusters of golden yellow needles, around a nucleus
Morphine	Wagner's	Heavy red brown precipitate in shining overlapping plates extending in branches
Nicotine	Mercuric chloride	Radiating transparent blades in slight excess of $H_2SO_4$ . Feather-like blades with HCl
Pilocarpine	Platinic chloride	Layers of thin, yellow triangular plates
Strychnine	Platinic chloride	Clusters of wedge shaped needles moving about in the field

tions of water, pass through a dry paper filter, evaporate slowly on a steam bath to remove the solvents, and take up the residue in four drops of water.

Of the common alkaloids this residue may contain atropine, brucine, codeine, heroin, morphine, cocaine, nicotine, pilocarpine, and strychnine. With a glass rod transfer three separate drops to a glass microscope slide. To the first drop by means of a glass rod add a drop of Wagner's reagent, to the second a drop of mercuric chloride solution, and to the third a drop of platinic chloride solution. The formation of a precipitate in any of the drops indicates the presence of an alkaloid. For identification, examine the slide under a microscope without stirring or covering (100-150 magnifications) and compare crystal characteristics with known controls prepared in the same manner, and also with comparison chart. Confirmatory tests for specific alkaloids may then be applied.

**Oxalates.** Make the water solution obtained in the extraction of alkaloids slightly acid with hydrochloric acid and warm on a steam bath to remove residual ether and chloroform. Add 1 ml. of calcium chloride solution, prepared by dissolving 10 gm.  $\text{CaCl}_2$  in water and diluting to 100 ml.; make ammoniacal, filter, and wash the precipitate with water. Redissolve the precipitate in 5 ml. of hot dilute hydrochloric acid, filter, wash with water, and evaporate the filtrate almost to dryness on a steam bath. Cool, take up in 25 ml. of 95% alcohol, and then add 25 ml. of ether. Filter through paper and repeat if necessary until a clear solution is obtained. Evaporate off the ether and alcohol on a steam bath and take up residue in a few milliliters of water. Add 1 ml. of calcium chloride solution and make ammoniacal. The presence of oxalic acid is indicated by the formation of a white, silky precipitate of calcium oxalate.

**Confirmatory Test.** Filter the precipitate, wash with water, and dissolve in a small amount of hot dilute hydrochloric acid. The decolorization of a drop of potassium permanganate solution added confirms the presence of oxalic acid.

**Methyl Alcohol and Formaldehyde. Reagent:** Chromotropic Acid Solution: Dissolve 5 mg. of chromotropic acid, 1,8 dihydroxynaphthalene-3,6-disulfonic acid, in 10 ml. of a mixture of 9 ml. of concentrated sulfuric acid and 4 ml. of water.

**Procedure.** Transfer 1 drop of the distillate obtained in the extrac-

tion of alkaloids to each of two test tubes. To the first tube add a drop of water, a drop of phosphoric acid solution, a drop of potassium permanganate solution, let stand for 1 minute, then add sodium bisulfite solution drop by drop until the permanganate color is discharged. If a brown color remains, add another drop of phosphoric acid solution. To both tubes now add 5 ml. of freshly prepared chromotropic acid solution and heat in a water bath at 60° C for 10 minutes. The appearance of a violet color in both tubes indicates the presence of formaldehyde and possibly methyl alcohol. If the color appears only in the tube oxidized with permanganate, then methyl alcohol alone is present.

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## APPENDIX

### GLOSSARY

Many of the words in this glossary are ordinarily familiar only to the physician. Their alphabetical arrangement will assist you in familiarizing yourself with and understanding better all the information in this manual. In many cases the definitions are in the restricted sense as applied to the field of poisons; for their wider meanings see any standard dictionary.

<i>abdomen</i>	The lower part of the belly.
<i>abortion</i>	Miscarriage; failure to mature.
<i>absorb</i>	To drink in; to suck up.
<i>absorbent</i>	A substance that increases the absorption of diseased tissue.
<i>absorption</i>	The act of absorbing.
<i>accidental</i>	Happening unexpectedly or unintentionally.
<i>acetates</i>	Salts formed by the reaction of acetic acid and a base.
<i>acid</i>	Sour; any compound containing hydrogen replaceable by metals.
<i>acrid</i>	Sharp; having a biting taste; pungent.
<i>acute</i>	Attended with severe symptoms and coming speedily to a crisis.
<i>addict</i>	One who takes a drug habitually and cannot endure to be deprived of it.
<i>addiction</i>	A state of habituation to taking a drug such that deprivation is not tolerated.
<i>administer</i>	To apply; to tender.
<i>administration</i>	The act of applying.
<i>adrenaline</i>	An extract from the secretion of the suprarenal glands, used as a stimulant or astringent.
<i>affinity</i>	Attraction between bodies to form compounds.
<i>afterdamp</i>	Carbon dioxide accumulated in mines, etc.
<i>alimentary canal</i>	The tube from mouth to anus, through which food passes.

<i>alkali</i>	Any acid-destroying compound that turns litmus blue.
<i>alkaline</i>	Having the qualities of an alkali.
<i>alkaloid</i>	An organic nitrogen base, of vegetable origin, usually toxic.
<i>alloy</i>	A compound or mixture of elements, at least one of them a metal, e.g. brass, an alloy of copper and zinc.
<i>alpha particle</i>	A positively charged helium nucleus.
<i>alpha rays</i>	A stream or beam of alpha particles moving at similar speeds in the same direction.
<i>analgesic</i>	A substance that relieves pain.
<i>analogous</i>	Presenting some resemblance.
<i>analysis</i>	The resolution of anything into its constituent elements.
<i>analytical</i>	Resolving into constituent parts; pertaining to analysis.
<i>anatomical</i>	Belonging to anatomy, the science of the structure of animals or of the art of dissecting animals.
<i>anemia</i>	A deficiency of the blood causing ill health, paleness.
<i>anesthetic</i>	Producing loss of feeling or insensibility to pain; any substance used to produce this effect.
<i>aniline</i>	A substance furnishing brilliant dyes.
<i>antacid</i>	Any substance that neutralizes acids.
<i>antidote</i>	A counterpoison; that which counteracts anything noxious. See page 32.
<i>antiemetic</i>	Any substance used to check vomiting.
<i>antipyretic</i>	Any substance that reduces fever.
<i>antiseptic</i>	Any substance that checks the growth of bacteria.
<i>antispasmodic</i>	Any substance that lessens convulsions and muscle contraction.
<i>antizymotic</i>	Any substance that checks germ action.
<i>aperient</i>	Any substance that produces bowel movements.
<i>apoplexy</i>	A sudden stroke, usually caused by effusion of blood in the brain.
<i>aqueous</i>	Of the nature of water, made from water.
<i>artificial</i>	
<i>respiration</i>	A method of giving breath to a person manually.
<i>asphyxia</i>	Suspended animation caused by shortage of oxygen in the blood; cessation of the motions of the heart, as in drowning or suffocation.
<i>astringent</i>	A medicine that causes contraction of the muscle fibers and hardens tissue.
<i>avoir.</i>	The abbreviation used in this book for <i>avoirdupois weight</i> .
<i>bacillus</i>	Microscopic, rodlike form of bacteria; some bacilli are capable of causing disease.
<i>bacteria</i>	A widely distributed group of microscopic one-celled organisms, living on dead or live organic matter (and

	some on inorganic matter) and causing a great variety of processes and conditions affecting animal and vegetable life, e.g., decay, disease.
<i>beta particles</i>	Negatively charged particles (electrons) emitted at high velocities from radioactive substances.
<i>beta rays</i>	Streams of beta particles.
<i>bile</i>	A greenish, bitter fluid secreted by the liver; gall.
<i>bitters</i>	Substances that increase the appetite and the flow of gastric juice.
<i>bleaching</i>	Act or art of whitening, especially by chemical processes.
<i>brittle</i>	Fragile; easily broken.
<i>bromides</i>	Compounds of bromine and some metal, as potassium bromide.
<i>bronchitis</i>	Inflammation of the mucous membranes of the bronchial tubes.
<i>bronchopneumonia</i>	Inflammation of the lungs.
<i>cachexia</i>	General ill health and undernutrition.
<i>calibrations</i>	Corrections, as of the errors in a thermometer.
<i>capsule</i>	A small envelope of gelatin containing medicine.
<i>carbonaceous</i>	Of carbon.
<i>cardiac</i>	Of the heart.
<i>cardiac depressant</i>	A heart depressor; that which lessens heart activity and causes the heart to beat more slowly and more weakly.
<i>cardiac stimulant</i>	A heart stimulant, that which increases heart activity and makes it beat faster and stronger.
<i>catalyst</i>	A substance which speeds up chemical change without itself being diminished or increased in quantity.
<i>cathartic</i>	A substance that causes bowel movement.
<i>caustic</i>	A substance that has the power to eat away animal tissue by chemical action.
<i>cauterizing</i>	Burning or searing with a hot iron or with some caustic agent, as of a wound, to destroy morbid tissue.
<i>ceramics</i>	Pottery; baked substance containing clay.
<i>cerebral depressants</i>	Substances that lessen brain activity. In large doses they induce sleep.
<i>cerebral stimulants</i>	Substances that increase brain activity and make the patient brighter, more talkative, and more active. In large doses they produce hallucinations, convulsions, delirium, etc.
<i>characteristic</i>	Of the nature of; typical of.
<i>chemical</i>	Produced by, or used in operations of chemistry.
<i>chemical analysis</i>	Resolving a substance into its elements through chemical means and determining their nature and proportions.
<i>chokedamp</i>	Carbon dioxide accumulated in mines, etc.
<i>chronic</i>	Continuing for a long time, as a disease.

<i>cinnabar</i>	Red sulfide of mercury.
<i>circulation</i>	Flow of blood through the body from and back to the heart.
<i>clammy</i>	Sticky; moist.
<i>colic</i>	A painful disorder in the abdomen.
<i>collapse</i>	Sudden failure; sudden prostration.
<i>coma</i>	Unconsciousness from which the patient cannot be aroused by external stimulants.
<i>combustible</i>	Capable of taking fire and burning.
<i>combustion</i>	The act of burning.
<i>components</i>	Parts of a mixture; ingredients of a mixture.
<i>compound</i>	Any substance composed of two or more chemical elements.
<i>compounded</i>	Mixed or combined, as of drugs.
<i>concentrated</i>	Increased in strength or proportion.
<i>concentration</i>	Strength, proportion of material dissolved.
<i>constipation</i>	Clogging of the bowels.
<i>constituents</i>	Parts of a compound; ingredients of a compound.
<i>contaminated</i>	Soiled; corrupted; polluted; tainted.
<i>contracted</i>	Shrunk; made smaller.
<i>converted</i>	Changed from one state to another.
<i>convulsant</i>	A substance that produces convulsions.
<i>convulsion</i>	Any violent motion or agitation; spasm.
<i>convulsive</i>	Marked by involuntary contraction of the muscles.
<i>corpuscles</i>	In anatomy, cells, as red or white corpuscles, in the blood.
<i>corrosive</i>	Any substance that eats away.
<i>corundum</i>	A very hard mineral substance used in abrasives.
<i>countenance</i>	Features; face.
<i>counterirritant</i>	Any substance relieving inflammation in remote tissues and organs.
<i>crude</i>	Raw; in natural state.
<i>crystal</i>	Any substance whose constituent elements have assumed a regular geometric pattern.
<i>crystalline</i>	Resembling crystal; transparent.
<i>cyanosis</i>	Blue discoloration of the skin from lack of oxygen in the blood.
<i>cylinder</i>	A body of roller-like form.
<i>deceased</i>	Dead.
<i>deliriant</i>	An agent causing delirium.
<i>delirium</i>	A fever of the brain.
<i>demulcent</i>	A substance used to soften and soothe.
<i>deodorant</i>	A substance that destroys foul odors.
<i>deodorizer</i>	A substance used to disinfect and to deprive of odor.
<i>depressant</i>	A substance that lessens activity, generally lowering the spirit.

<i>depression</i>	A low state of spirits.
<i>detergent</i>	A substance used to clean the skin and wounds.
<i>diaphoretic</i>	A substance used to cause perspiration.
<i>diarrhea</i>	A frequent purging of the bowels.
<i>dilate</i>	To increase or widen in all directions.
<i>dilute</i>	To diminish the strength of, by mixing.
<i>disinfect</i>	To free from infectious matter.
<i>disinfectant</i>	A substance used to free from infectious matter.
<i>dissolution</i>	The act of dissolving, breaking up; decomposition.
<i>dissolve</i>	To make a solution of.
<i>distillation</i>	The process of heating a mixture until one or more components become vapor; the vapor is then condensed to liquid form.
<i>dose</i>	The quantity of medicine taken at one time. See page 14.
<i>dram</i>	The eighth part of the apothecaries' table or fluid ounce.
<i>drug</i>	Any substance used primarily as a medicine; in particular, one of the habit-forming drugs, as morphine, heroin, cocaine.
<i>drug habit</i>	The tendency to repeat the use of a drug to produce pleasure or relieve craving.
<i>dyspnea</i>	Difficult or labored breathing.
<i>edema</i>	Accumulation of body fluid in the connective tissue, marked by swelling.
<i>edible</i>	Fit to be eaten.
<i>electrolysis</i>	The separation of a compound into its several parts by electricity.
<i>element</i>	A substance that cannot be analyzed or broken down into other substances by ordinary chemical methods.
<i>eliminate</i>	To expel from the system.
<i>emetic</i>	A substance used to induce vomiting. See page 30.
<i>epigastric</i>	Pertaining to the abdominal region.
<i>epigastrium</i>	A region of the abdomen.
<i>eruption</i>	Act of bursting forth.
<i>escharotic</i>	A caustic, a substance that destroys the skin it touches.
<i>esophagus</i>	The canal, about 9 inches in length, extending from the pharynx to the stomach.
<i>evacuate</i>	To make empty, to empty out.
<i>evacuation</i>	Act of emptying.
<i>evaporate</i>	To pass off in vapor.
<i>exhaustion</i>	A state of being completely weary.
<i>exhilaration</i>	Animation; unusual gaiety.
<i>expectorant</i>	A substance that increases the discharge of mucus or other fluids from the lungs and throat.

<i>extract</i>	To pull or draw out (verb); that which is extracted or gotten out of a mixture (noun).
<i>extremity</i>	Arm or leg; terminal end of any organ, hand or foot.
<i>exudation</i>	A discharging through the pores.
<i>fabric</i>	Textiles; material.
<i>fatal dose</i>	The smallest amount of a substance that is known to have caused the death of an adult.
<i>feces</i>	Excrement; the discharge of the bowels.
<i>fermentation</i>	A decomposition produced by microorganisms in an organic substance, such as the decomposition of sugar by yeast, or the souring of milk.
<i>filter</i>	A strainer; an apparatus used for clearing or purifying liquids.
<i>filtrate</i>	The liquid that runs through the filter, as distinguished from the solid precipitate that remains on the filter.
<i>filtration</i>	The process of removing suspended matter from a liquid by passing it through something porous.
<i>flakes</i>	Scalelike particles, as of snow.
<i>flexible</i>	Easily bent; pliant; supple.
<i>fluid</i>	Though gases as well as liquids are considered fluids, in this book the term implies a liquid.
<i>formula</i>	A group of symbols expressing the composition of a chemical compound.
<i>fume</i>	To send forth as smoke and vapor (verb); the smoke or vapor (noun).
<i>fumigant</i>	A substance such as a poisonous gas or liquid which can form a vapor easily that is used to kill rodents, insects, and microorganisms.
<i>fumigating</i>	Act of using fumigants for the destruction of pests.
<i>functioning</i>	Performing.
<i>fungicide</i>	A chemical used to kill a fungus growth.
<i>fungus growth</i>	One of the nongreen plants, including molds, mushrooms, toadstools, etc. that feed upon organic matter.
<i>fusible</i>	Capable of being melted or liquefied.
<i>fusion</i>	The act of melting, or state of being melted; the blending together of things.
<i>gamma rays</i>	Electromagnetic radiations of very short wave length, shorter than x-rays and therefore very penetrating; they are emitted in reactions involving radioactive changes.
<i>gaseous</i>	In the form of gas.
<i>generated</i>	Produced; originated by chemical or physical processes.
<i>genitals</i>	The sex organs.
<i>germicide</i>	Destructive of bacteria.

<i>germicide</i>	Any substance used to kill bacteria.
<i>glucosides</i>	Any member of a series of compounds that may be resolved by an acid into glucose (a sugar) and another principle.
<i>grain</i>	The twentieth part of a scruple in apothecaries' weight.
<i>gram</i>	A unit of weight in the metric system, the weight of a cubic centimeter of pure water at its maximum density, which is reached at 3.98° C. Abbreviated <i>gm.</i> in this book.
<i>granular</i>	Consisting of grains; grainy.
<i>granules</i>	Small particles.
<i>gums</i>	Juices that exude from trees and thicken on the surface.
<i>hallucination</i>	Illusory perception, as "seeing things," or "hearing voices."
<i>havoc</i>	Devastation.
<i>hemoglobin</i>	A substance contained in the red corpuscles of the blood that gives the blood its color, combines with oxygen in the lungs, and transfers it to the rest of the body.
<i>herbicide</i>	A chemical used to kill weeds and plants.
<i>homicide</i>	The killing of one person by another.
<i>horizontal</i>	Parallel to the horizon, level.
<i>hormones</i>	Substances contained in glandular secretions that affect the functioning of various parts of the body
<i>hygroscopic</i>	Having the property of absorbing moisture from the air.
<i>hypnotic</i>	A substance tending to produce sleep.
<i>hypodermic</i>	Introduced under the skin, as a medicine.
<i>hypodermically</i>	By introduction under the skin.
<i>hysteria</i>	Uncontrollable emotional excitement.
<i>idiosyncrasy</i>	A characteristic trait peculiar to an individual.
<i>incapacitation</i>	Loss of fitness; loss of physical or intellectual power.
<i>induce</i>	To lead by persuasion or argument; bring on.
<i>infected</i>	Tainted with disease, poisoned.
<i>infection</i>	Invasion of and growth within an organism, like a human being, of harmful bacteria, viruses, or other microorganisms, with consequent development of disease.
<i>inflammable</i>	Easily set on fire.
<i>inflammation</i>	Redness and swelling of any part of the body, accompanied by heat and pain.
<i>ingested</i>	Taken into the stomach.
<i>ingestion</i>	Act of taking into the stomach.
<i>ingredient</i>	A component part of any mixture.
<i>inhalation</i>	The breathing in of air.
<i>inhalator</i>	A device aiding supply of oxygen to a patient.
<i>insecticides</i>	Substances used for killing bugs, flies, and other insects.



<i>insoluble</i>	Incapable of being dissolved.
<i>intense</i>	Extreme in degree.
<i>intestines</i>	The much-coiled canal or tube extending from the stomach to the anus.
<i>intolerant</i>	Unable to bear or endure.
<i>intravenously</i>	Into the veins by injection.
<i>irritant</i>	That which irritates.
<i>irritative</i>	Exciting or provocative; a substance that increases action.
<i>jaundice</i>	A disease characterized by yellowness of the eyes and skin, and caused by a suffusion of bile.
<i>laboratory</i>	A place for scientific operations and experiments.
<i>laryngeal</i>	Pertaining to the larynx.
<i>larynx</i>	The upper part of the windpipe; a cavity containing the vocal cords.
<i>lethal</i>	Mortal; deadly.
<i>lucifer</i>	A wood match tipped with a substance that is ignited by friction.
<i>Luminal</i>	(1) A trade name for a hypnotic; (2) pertaining to the lumen of a blood vessel.
<i>luminous</i>	Bright; lustrous; giving forth or spreading light.
<i>luster</i>	Brightness, shine from reflected light; gloss.
<i>lustrous</i>	Bright; glossy; shiny.
<i>malleable</i>	Capable of being worked or extended into a sheet by being hammered out.
<i>mania</i>	Madness, especially of the excited or elated type.
<i>maniacal</i>	Raving with madness
<i>medium</i>	That in which anything moves or through which it acts.
<i>metallic</i>	Pertaining to or resembling a metal.
<i>mg.</i>	Abbreviation for milligram.
<i>microgram</i>	The thousandth part of a milligram, or one millionth of a gram.
<i>milligram</i>	The thousandth part of a gram; .0154 of a grain.
<i>minim</i>	One sixtieth part of a dram; a single drop.
<i>ml.</i>	Abbreviation of milliliter, the thousandth part of a liter. In practice it does not differ from the cubic centimeter.
<i>morbid</i>	Sickly; unhealthy; caused by disease.
<i>mortality</i>	Death or death rate.
<i>mucous membrane</i>	The lining of the canals and cavities of the body.
<i>mutilate</i>	To maim; to destroy by removing an essential part.
<i>narcotic</i>	A drug producing sleep.
<i>nausea</i>	A desire to vomit; being "sick to one's stomach."

<i>necrosis</i>	Gangrene, especially of the bone.
<i>neurologic</i>	Pertaining to the nervous system.
<i>neutralize</i>	To render inactive; to destroy the characteristics of by chemical means or combination.
<i>neutron</i>	An elementary particle with no electric charge and about the same weight as a proton.
<i>nontoxic</i>	Not poisonous.
<i>notoriety</i>	The state of being well known, especially in an undesirable sense.
<i>noxious</i>	Harmful; injurious, deadly.
<i>obesity</i>	Excessive fatness.
<i>octahedral</i>	Having a form bounded by eight triangular surfaces.
<i>oleoresin</i>	A natural mixture of resins and volatile essential oils.
<i>opaque</i>	Not transparent, not allowing light to pass through
<i>optic nerve</i>	The nerve running from the eye to the centers of vision in the brain.
<i>organic</i>	Pertaining to a living organ or organs; <i>in chemistry</i> , containing carbon.
<i>oxide</i>	A compound of oxygen and another element.
<i>oxidize</i>	Combine with oxygen or any other nonmetal.
<i>oxidizing</i>	The act or process of becoming oxidized.
<i>oxidizing agent</i>	Any substance that can oxidize other substances.
<i>pallor</i>	Paleness; wanness.
<i>palpitation</i>	A violent beating of the heart.
<i>pancreas</i>	A gland in the abdomen beneath the stomach.
<i>paralysis</i>	Loss of power to move at will or to feel in any part of the body.
<i>paralyzing</i>	Impairing the control or energy of a body or limb
<i>parasite</i>	A plant or animal that lives at the expense of another.
<i>pathogenic bacteria</i>	Bacteria causing disease.
<i>pellet</i>	A little ball.
<i>persevering</i>	Continuing steadfastly.
<i>perspiration</i>	Sweating, sweat, the saline fluid given off in the process.
<i>pharynx</i>	Cavity forming back part of mouth and ending in the esophagus.
<i>pigments</i>	Coloring matter, as in paints, tissue, or other bodies.
<i>pliable</i>	Easy to bend; yielding; flexible.
<i>polluted</i>	Fouled; unclean, corrupted.
<i>post mortem</i>	After death.
<i>ppm.</i>	Abbreviation for parts per million. See page 145.
<i>precipitate</i>	An insoluble substance formed in a solution by chemical reaction.
<i>preservative</i>	A substance that prevents decay.

<i>prism</i>	A solid whose two ends are identical in size and shape, and parallel; and whose sides are parallel four-sided figures.
<i>pungent</i>	Acrid; sharply affecting the taste or smell; sharply painful.
<i>purging</i>	Free evacuation of the bowels.
<i>rapidity</i>	Swiftness; quickness.
<i>react</i>	In chemistry, to undergo a chemical change.
<i>reagent</i>	Any substance used to take part in a chemical reaction.
<i>rectum</i>	Terminal part of the large intestine, about 8 inches long in the adult.
<i>reflex</i>	A nerve impulse directed back to a muscle without taking time to travel to the brain, such as the protective action that instantly lifts the hand when it touches a hot stove.
<i>refrigerant</i>	A substance or material that can be used for cooling purposes.
<i>resin</i>	Hardened sap that exudes from trees and plants.
<i>respiration</i>	The act of breathing.
<i>respiratory failure</i>	Failure to breathe.
<i>respiratory tract</i>	The group of organs, including the pharynx, trachea, and lungs, serving for respiration.
<i>retard</i>	Hinder; delay.
<i>retching</i>	Attempting to vomit.
<i>rigid</i>	Not easily bent; stiff.
<i>rigidity</i>	Want of pliability; property of resisting change in shape.
<i>rigor</i>	State of being rigid.
<i>rigor mortis</i>	Stiffening of the body after death.
<i>rodenticide</i>	A chemical used to kill rodents, that is, rats, mice, etc.
<i>saccharated</i>	Sweetened.
<i>salicylate</i>	A salt of salicylic acid.
<i>saline</i>	Containing salt, i.e., sodium chloride, salty; water containing the same proportion of salt as is found in the blood.
<i>salivation</i>	Excessive secretion of saliva.
<i>salt</i>	A product formed by neutralization of any acid with any base; <i>specifically</i> , sodium chloride (ordinary table salt).
<i>saponin</i>	An expectorant, emetic, and alterative glucoside from <i>Saponaria officinalis</i> .
<i>sardonic</i>	Forced, heartless, mocking; as of a laugh or smile.
<i>saturated</i>	Soaked; of a solution containing as much dissolved material as is possible at the given temperature.
<i>saturation</i>	Act of soaking.

<i>secretion</i>	The matter secreted, or separated and discharged by a cell or cells, e.g., milk, saliva.
<i>sedative</i>	A remedy that allays irritability or pain.
<i>sensory nerve</i>	A nerve transmitting impulses from the rest of the body to the spinal cord and brain.
<i>sequence</i>	Order of succession.
<i>shellac</i>	Crude lac melted into plates or cakes for varnish.
<i>soluble</i>	Capable of being dissolved.
<i>solution</i>	Reduction of a body to a fluid state by combination with a liquid.
<i>solvent</i>	A substance having the power of dissolving another substance.
<i>spasm</i>	An involuntary contraction of muscles.
<i>specimen</i>	An individual viewed as a sample of a type.
<i>stability</i>	Being stable or firm.
<i>stagnation</i>	Being stale or foul from long standing.
<i>stimulant</i>	A substance inciting and producing vital action.
<i>stimulates</i>	Rouses to activity; produces a temporary increase of vitality or activity.
<i>stimulation</i>	Excitement, producing a temporary increase of vitality or energy.
<i>stomach tube</i>	A flexible tube for irrigation, washing, or evacuation of the stomach.
<i>stool</i>	Discharge from the bowels.
<i>stupor</i>	Numbness; senselessness.
<i>styptic</i>	An agent that checks bleeding by causing contraction of the blood vessels.
<i>subacetate</i>	An acetate that has the OH group within it, e.g., cupric subacetate $\text{Cu}(\text{OH})(\text{C}_4\text{H}_7\text{O}_2)$ .
<i>subacute</i>	Moderately acute.
<i>subcutaneously</i>	Beneath the skin
<i>sublimable</i>	Capable of being sublimed
<i>sublimate</i>	A substance that has been sublimed; to purify.
<i>sublime</i>	To pass directly from the solid to the gaseous state; e.g., iodine sublimates.
<i>subnormal</i>	Below or less than normal.
<i>substance</i>	The material of which anything is composed.
<i>suicidal</i>	Self-destructive.
<i>suicide</i>	Self murder.
<i>susceptibility</i>	Capacity for taking up, of having little resistance to a disease, poison, etc.
<i>susceptible</i>	Yielding readily, liable, sensitive, likely to take up.
<i>suspended</i>	Caused to cease for a time; supported, as a dust in air, or a solid in liquid.
<i>synthesis</i>	The uniting of elements to form a compound.

<i>synthetically</i>	By or based on synthesis, or on putting of elements together in a new form.
<i>systemic</i>	Affecting the whole body.
<i>tannins</i>	Astringent substances found in oak bark and other trees, used in tanning and dying.
<i>tetanic</i>	Of tetanus, lockjaw (a disease characterized by spasmodic and continuous contraction of the muscles).
<i>tissue</i>	The texture of elements of which any part of the body is composed.
<i>tolerance</i>	Ability to endure a poison or a drug that may be harmful if taken in excess.
<i>toxemia</i>	Blood poisoning.
<i>toxic</i>	Poisonous.
<i>toxicity</i>	State of being toxic.
<i>toxicologic</i>	Dealing with poisons.
<i>toxicology</i>	The branch of chemistry dealing with poisons.
<i>toxin</i>	A poisonous substance, especially a poison secreted by a living organism, as bacteria or an insect.
<i>trachea</i>	Windpipe, the main tube by which air goes to and from the lungs.
<i>tract</i>	An area.
<i>transfusion</i>	A transfer of blood into the veins from an external source.
<i>translucent</i>	Semitransparent; permitting passage of light without clear vision of objects beyond.
<i>trunk</i>	The body without head, arms, or legs.
<i>ulcer</i>	An open sore, containing pus, on the external or internal surface of the body.
<i>urethra</i>	The canal by which the urine is discharged.
<i>urine</i>	A fluid excreted by the kidneys.
<i>U.S.P.</i>	Abbreviation for United States Pharmacopeia.
<i>vagina</i>	In the female genitals, the canal extending from the vulval opening to the neck of the womb.
<i>vapor</i>	Gaseous bodies formed from liquids by increase in temperature but which readily resume their liquid state when the temperature is lowered; visible moisture or steam.
<i>variable</i>	Changeable.
<i>vascular</i>	Consisting of, pertaining to, or provided with vessels, as blood vessels.
<i>ventilation</i>	Replacement of used air; the act of supplying fresh air.
<i>vermin</i>	Objectionable small animals or insects, as rats, mice, lice, etc.
<i>vertigo</i>	Dizziness; giddiness.

<i>volatile</i>	Having the power of evaporating and forming a vapor.
<i>volatilize</i>	To convert into vapor by means of heat.
<i>vomiting</i>	Throwing up; ejecting contents of the stomach via the mouth.
<i>vomit</i>	The matter ejected from the stomach in vomiting.

## ANALYTICAL REAGENTS

*Most substances are required in water solutions. To prepare these, place the amount of substance indicated below in a 100 cc. volumetric flask; dissolve in distilled water; and finally dilute to the mark. This gives 100 cc. of a solution of 1 molar concentration, excepting in special cases, which are noted.*

Acetic acid, glacial

Acetic acid, dilute (29 cc. of glacial acetic acid = 5 Normal)

Ammonium carbonate [57 gm.  $(\text{NH}_4)_2\text{CO}_3 \cdot \text{H}_2\text{O}$ ]

Ammonium hydroxide, dilute (33 cc. conc.  $\text{NH}_4\text{OH}$  = 5 Normal)

Ammonium oxalate [8 gm.  $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ ]

Ammonium sulfide, colorless, aq.

Ammonium vanadate, *see* Mandelin's reagent

Aniline

Barium chloride (12.2 gm.  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ )

Benzidine (saturated solution, as much as will dissolve in glacial acetic acid)

Bromine, liquid

Bromine (2 cc. = 2% solution)

Calcium chloride (10 gm.  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ )

Calcium hypochlorite (solid  $\text{CaOCl}_2$ , only; just before use dissolve 5 gm. in 95 cc. water = 5% solution)

Calcium oxide (0.05 gm., then filter; clear solution is limewater)

Chlorine water (saturated solution)

Chloroform

Copper foil, arsenic-free

Copper-pyridine reagent (5 cc. pyridine added to a solution of 2.0 gm. hydrous copper sulfate in 45 cc. water)

Cupric acetate [3 gm.  $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$  = 3% solution]

Ether



Ethyl alcohol (95%  $C_2H_5OH$ )

Ferric chloride (27 gm.  $FeCl_3 \cdot 6H_2O$ )

Formaldehyde (formalin, 40% solution)

Froehde's reagent (0.2 gm. molybdic acid in 100 cc. conc.  $H_2SO_4$ )

Hoshida's reagent (0.3 gm. ammonium molybdate and 0.5 cc. 40% formalin in 60 cc. conc.  $H_2SO_4$ )

Hydrobromic acid

Hydrochloric acid, arsenic-free, conc. (sp. gr. 1.19)

Hydrochloric acid, dil. (41.6 cc. conc.  $HCl = 5$  Normal)

Hydrogen peroxide (3% solution)

Iodic acid

Iodine, tincture of

Lead acetate paper

Magnesium nitrate [about 23 gm.  $Mg(NO_3)_2 \cdot 6H_2O$ , as much as will dissolve; then make alkaline to litmus paper with  $MgO$ ]

Magnesium oxide, *see* Magnesium nitrate

Mandelin's reagent (1 gm. ammonium vanadate in 54 cc. conc.  $H_2SO_4$ )

Manganese dioxide, solid

Manganous chloride (19.8 gm.  $MnCl_2 \cdot 4H_2O$ )

Mayer's reagent (1.36 gm.  $HgCl_2 + 5$  gm.  $KI$  in 100 cc. water)

Mercuric chloride, *see* Mayer's reagent

Mercury, *see* Millon's reagent

Methyl orange (2.5 gm. in water = 2.5% solution)

Millon's reagent (5 gm.  $Hg + 5$  cc. fuming nitric acid + 10 cc.  $H_2O$ )

Molybdic acid, *see* Froehde's reagent

Naphthol, beta (5 gm. in 120 cc. ethyl alcohol = 5% solution)

Nitric acid, fuming

Nitric acid, conc. (sp. gr. 1.42)

Nitric acid, dil. (22.2 cc. conc.  $HNO_3 = 5$  Normal)

Palladous chloride (2 gm.  $PdCl_2 \cdot 2H_2O = 2\%$  solution)

Phenol (as much as will dissolve in water, about 8 gm.)

Phenyl hydrazine hydrochloride (5 gm. = 5% aq. solution)

Phosphoric acid, syrupy

Potassium dichromate, crystals ( $K_2Cr_2O_7$ )

Potassium dichromate (29.4 gm.  $K_2Cr_2O_7$ )

Potassium ferrocyanide (10.6 gm.  $K_4Fe(CN)_6 \cdot 3H_2O$ )

Potassium hydroxide (5.6 gm.  $KOH$ )

Potassium iodide (16.6 gm.  $KI$ ; also for Mayer's reagent)

Potassium nitrite (8.5 gm.  $KNO_2$ )



Potassium permanganate (15.8 gm.  $\text{KMnO}_4$ )

Pyridine

Resorcinol [11 gm.  $\text{C}_6\text{H}_4(\text{OH})_2$ ]

Silver nitrate (1.7 gm.  $\text{AgNO}_3 = 0.1$  molar)

Sodium bicarbonate (8.4 gm.  $\text{NaHCO}_3$ , baking soda)

Sodium carbonate (28.6 gm.  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ , washing soda)

Sodium hydroxide (4.0 gm.  $\text{NaOH}$ )

Sodium molybdate (24.2 gm.  $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ )

Sodium nitrate (8.5 gm.  $\text{NaNO}_3$ )

Sodium nitroprusside [0.5 gm.  $\text{Na}_2\text{Fe}(\text{CN})_5\text{NO} \cdot 2\text{H}_2\text{O} = 0.5\%$  solution]

Sodium oxalate (13.4 gm.  $\text{Na}_2\text{C}_2\text{O}_4$ )

Stannous chloride, crystals (make up fresh solution by adding 22.5 gm.  $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$  to 100 cc. water)

Starch iodide paper

Sulfuric acid, conc. (sp. gr. 1.84)

Sulfuric acid, dil. (Care! add 13.3 cc. conc.  $\text{H}_2\text{SO}_4$  to water, with stirring = 5 Normal)

Vanillin (1 gm. in 90 cc. conc.  $\text{HCl} = 1\%$  solution)

Zinc, mossy, arsenic-free

## APPARATUS

1 gross 30-cc. dropping bottles for reagents above

1 alcohol burner

5 beakers, 50 cc.

5 beakers, 250 cc.

2 volumetric flasks, 100 cc.

5 ft. glass rod, 5-mm.

5 ft. glass tubing, 6-mm. o.d.

1 doz. test tubes, small

3 in. platinum wire, about 0.01 in. in diameter

2 10-cc. graduated cylinders

2 100-cc. graduated cylinders

1 pkg. filter paper, qualitative, 11-cm.

1 test tube clamp

1 test-tube rack

2 funnels, glass, 40-mm., short stem

Glass wool

Cotton, paper towels, matches, wood splints, etc.

## TABLE OF WEIGHTS AND MEASURES

## TROY WEIGHT

1 pound = 22.816 cubic inches of distilled water at 62° F.

Grains		Dwt.		Ounce		Pound
24	=	1				
480	=	20	=	1		
5760	=	240	=	12	=	1

## AVOIRDUPOIS WEIGHT

1 pound avoirdupois = 1.2153 pounds troy

Grains (gr.)		Drams (dr.)		Ounces (oz.)		Pound (lb.)
27.34375	=	1				
437.5	=	16	=	1		
7000	=	256	=	16	=	1

## APOTHECARIES' WEIGHT

Grains (gr.)	Scruples (℥)	Drams (ʒ)	Troy		Pound (lb.)
			Ounces (oz.)		
20 =	1				
60 =	3 =	1			
480 =	24 =	8 =	1		
5760 =	288 =	96 =	12 =		1

## APOTHECARIES' MEASURE

Minims (m)	Fluid drams (fʒ)		Fluid ounces (fʒ)		Pints (O)	Gallons (C)		
60	=	1						
480	=	8	=	1				
7,680	=	128	=	16	=	1		
61,440	=	1024	=	128	=	8	=	1

## IMPERIAL MEASURE

Minims		Fluid drams		Fluid ounces		Pints		Gallons
60	=	1	=					
480	=	8	=	1				
9,600	=	160	=	20	=	1		
76,800	=	1280	=	160	=	8	=	1

## HOUSEHOLD UTENSILS (APPROXIMATE)

20 grains .....	About the quantity of solid that can be piled on a 25-cent piece
1 dram or 4 grams .....	About 1 level teaspoonful
2 drams or 8 grams .....	About 1 level dessertspoonful
4 drams or 16 grams or $\frac{1}{2}$ ounce ..	About 1 level tablespoonful
8 ounces or 240 cc. ....	About 1 tumblerful

## UNITED STATES COIN WEIGHTS (APPROXIMATE)

One 50¢ piece = 12.5	grams = 200	grains = (avoir.)
One 25¢ piece = 6.25	grams = 100	grains = (avoir.)
One 10¢ piece = 2.5	grams = 40	grains = (avoir.)
One 5¢ piece = 5	grams = 80	grains = (avoir.)
One 1¢ piece = 3.1	grams = 50	grains = (avoir.)
One 10¢ piece + two 50¢ pieces = 27.5	grams = 440	grains, or about 1 ounce

## TROY EQUIVALENTS OF METRIC DOSES

0.1 gm. (1 decigram) .....	Over $1\frac{1}{2}$ grains
0.2 gm. (2 decigrams) .....	Over 3 grains
0.3 gm. (3 decigrams) .....	Over $4\frac{1}{2}$ grains
0.6 gm. (6 decigrams) .....	Over 9 grains
1 gm. (1 gram) .....	Over 15 grains
2 gm. (2 grams) .....	Over 30 grains

Grains	Milligrams	Grains
1	65	0.065
$\frac{1}{2}$	32	0.032
$\frac{1}{4}$	16	0.016
$\frac{1}{8}$	8.0	0.008
$\frac{1}{16}$	4.1	0.0041
$\frac{1}{32}$	3.2	0.0032
$\frac{1}{64}$	2.6	0.0026
$\frac{1}{128}$	2.2	0.0022
$\frac{1}{256}$	1.6	0.0016
$\frac{1}{512}$	1.3	0.0013
$\frac{1}{1024}$	1.1	0.0011
$\frac{1}{2048}$	1.0	0.0010
$\frac{1}{4096}$	0.65	0.00065
$\frac{1}{8192}$	0.54	0.00054
$\frac{1}{16384}$	0.43	0.00043
$\frac{1}{32768}$	0.32	0.00032
$\frac{1}{65536}$	0.11	0.00011

## EXACT MEASUREMENTS

An example best illustrates how to use the following tables. To convert 5 gallons into pints, look for gallons on the vertical line; now move along horizontally from this to the space under pints. The number in this space is 8. From this we calculate that 5 gallons is equal to  $5 \times 8 = 40$  pints.

## SOLID WEIGHT

(Troy, Apothecary, and Metric)

	dram (troy)	grain	gram	ounce (troy)	pound (troy)	scruple
1 Dram (Troy) =	.....	60	3.89	0.125	$\frac{1}{8}$	3
1 Grain =	0.0167	.....	0.0648	0.00208	$\frac{1}{5760}$	0.050
1 Gram =	0.257	15.43	.....	0.2322	0.00268	0.772
1 Ounce (Troy) =	8	480	31.1	.....	$\frac{1}{12}$	24
1 Pound (Troy) =	96	5760	373.2	12	.....	288
1 Scruple =	0.333	20	1.30	0.0417	0.00347	.....

## LIQUID MEASURE

(Troy and U. S. Fluid)

	cc.	dram U. S. fluid	gallon U. S. fluid	minim U. S. fluid	ounce U. S. fluid	pint U. S. liquid	quart U. S. liquid
1 cc. =	.....	0.271	0.0002	16.2	0.0338	0.00211	0.00106
1 dram (fluid) =	3.70	.....	0.00098	60	0.125	0.00781	0.00391
1 gallon (fluid) =	3785	1024	.....	61440	128	8	4
1 minim (fluid) =	0.0616	$\frac{1}{80}$	0.0000163	.....	$\frac{1}{480}$	0.00013	0.000065
1 ounce (fluid) =	29.6	8	$\frac{1}{128}$	480	.....	$\frac{1}{16}$	0.0313
1 pint (liquid) =	473.2	128	0.125	7680	16	.....	0.5
1 quart (liquid) =	946.4	256	0.25	15360	32	2	.....

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